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SCIENCE

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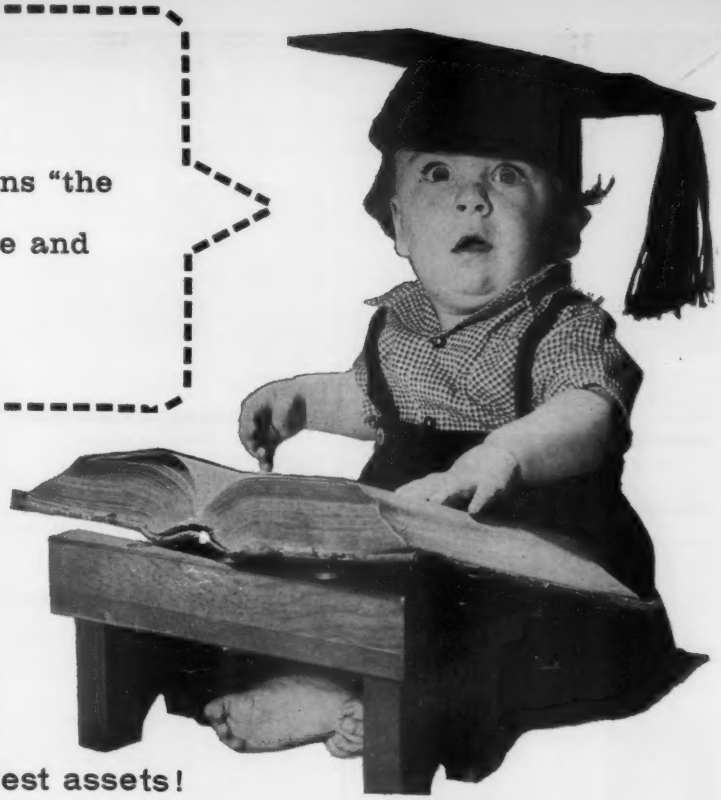

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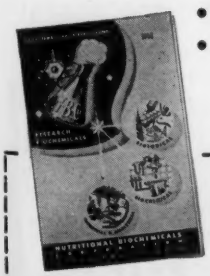

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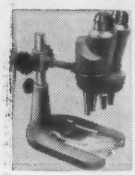

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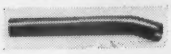

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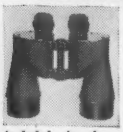

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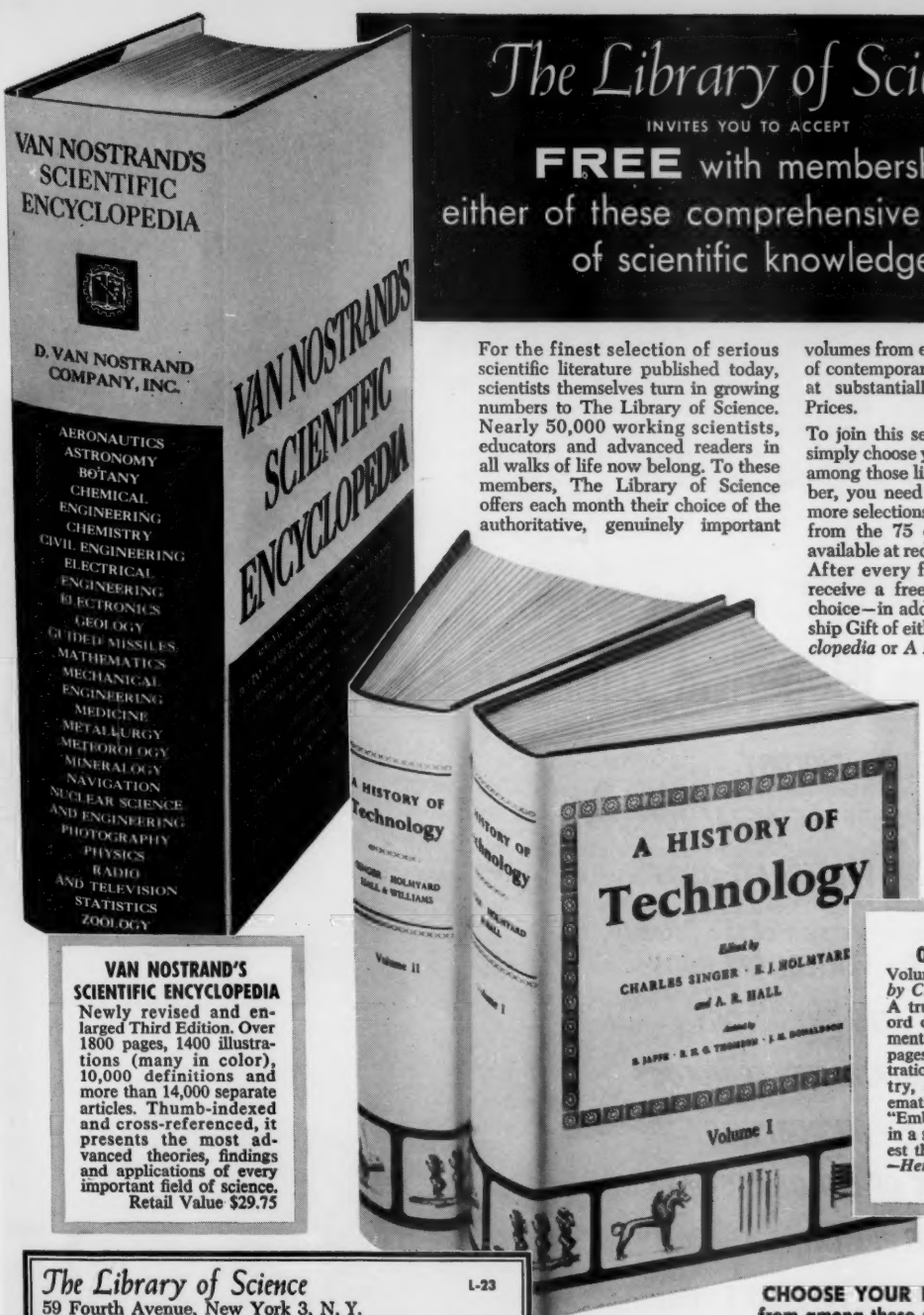

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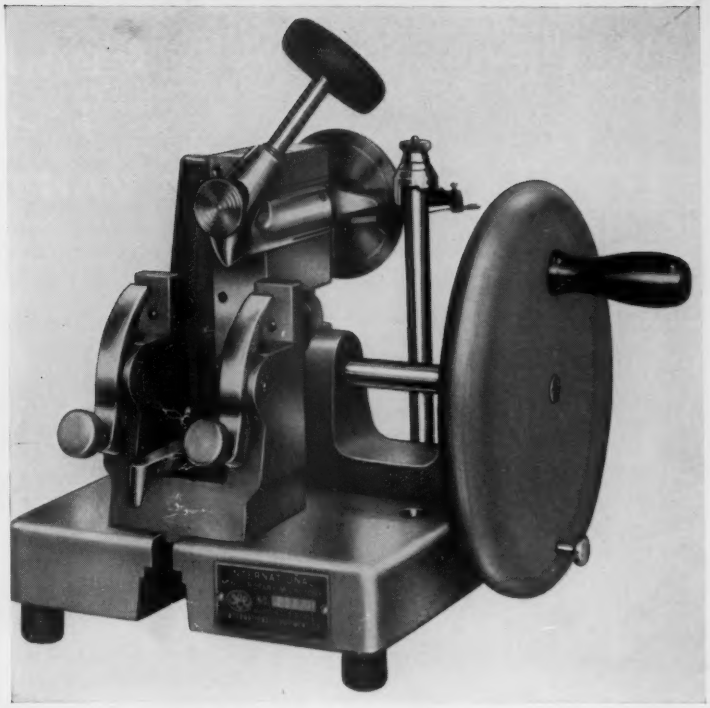

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Letters

German Scientists and Atom Bomb

If any proof were still needed of the unfortunate fact that some scientists, when discussing political or moral problems, tend to think unscientifically, Condon's thoroughly prejudiced review of my book *Brighter Than a Thousand Suns* would become a prize exhibit [(*Science* **128**, 1619 (1958)].

In order to prove that I am "propagandizing" for a favorable view of some German scientists under the Hitler regime without "real evidence," he suppresses all the evidence in my book which does not suit him. Condon does not mention the fact that excellent men and proven opponents of the Hitler regime like Otto Hahn, Paul Rosebaud, Wolfgang Gentner, and Hans Suess (who has since become a United States citizen) deliberately refrained from helping the Nazi war machine (see pages 97 and 98 of my book). He suppresses the long story I have told about Fritz Houtermans, who completed his first study of the uranium problem in September 1940 and wrote during the war on the "Problems of Release of Nuclear Chain Reactions" but saw to it that this study did not get into the hands of the Army Weapons Department (page 95). Condon does not comment on Nobel prize winner Max von Laue's words, when consoling Houtermans, who came to him in panic after he had heard that Heisenberg and Weizsaecker had started working on the "uranium problem": "My dear colleague, no one ever invents anything he does not really want to invent" (page 94).

I maintain—and after all there is the main evidence behind me, the surprising fact that the German physicists, so greatly feared for their scientific ability, did make so amazingly little progress towards a nuclear bomb—that lack of enthusiasm—"passivism"—born out of their fear of what Hitler might do once he had an atomic bomb restrained their actions, whereas the scientists on the Allied side (and as a fighter for the Allied cause, who received the written official expression of gratitude from the United States Government for my active part in fighting Hitler, I am one who belongs with them) had then every reason to believe that their cause was just. But I feel that the dropping of the bomb on Hiroshima has somehow tarnished this proud feeling.

It is simply not true that I have been "singling out the atomic scientists for moral condemnation." First of all, I did not condemn them. I simply wanted to show that they became the captives of a machinery they had helped to build. Throughout my book I tried to make my reader feel some understanding of and compassion for men who, owing to the fact that they lived in a world in which science, politics, and morals were unfortunately "compartmentalized," finally acted as they did.

If there is a villain in my book it is that old-fashioned "specialization" born precisely in the German universities and later carried over into the American universities, which tends to make scientists narrow and one-sided by presenting a part of life rather than the whole of it—to turn them into people who agree sometimes much too easily with rather horrible decisions put before them. And if my book has any hero it is the new spirit of awakening universalism and modesty grown precisely out of the ghastly experience of the atom bomb.

I wholeheartedly agree with Condon that a team of historians ought to write the crucial history of those men as soon and as objectively as possible. Having gone into that field with fewer preconceived notions than some of the men who now defend in a rather emotional way the "official view" against the facts I have discovered, I am convinced that such a team will not only find fault with me but will also find some merit in my having unearthed some facts which until now had been buried under the bouquets of professional courtesy and veiled by the mist of nationalistic thinking.

ROBERT JUNGK

London, England

Source of Fallout

A question has been raised about the source of the fallout whose partial analysis we reported in the article "Long-lived cobalt isotopes observed in fallout" [*Science* **128**, 417 (1958)]. The objective of this article was to report the detection of measurable quantities of radiocobalt in three specific samples of fallout material. These quantities were expressed in terms of radiocobalt-strontium atom ratios. It was noted that the samples were from a single detonation.

It is now possible to state that the samples were from a "clean" bomb and that bombs of higher relative fission yield would result in lower cobalt-to-strontium ratios than those reported. Data available to us indicate that the amount of induced radiocobalt produced is approximately proportional to the total yield (fission plus fusion) of a weapon. Consequently, the Co^{60}/Sr^{90} ratio is proportional to the total-yield/fission yield ratio.

PETER O. STROM, JAMES L. MACKIN, DOUGLAS MACDONALD, PAUL E. ZIGMAN

U.S. Naval Radiological Defense Laboratory, San Francisco, California

Which speaker is making the sound? In echoless chamber at Bell Labs, Robert Hanson measures test subject's ability to localize sounds — observes how two ears operate in partnership. This and other tests may point the way to better telephone instruments.

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What makes *two* ears better than one?

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Our hearing performs feats that no electronic system can yet duplicate. How? Laboratories scientists believe the secret lies in the way our two ears function in partnership and in the way our neural network connects them with our brain. *The problem:* to discover what functions the network performs and to see whether electronic duplication might enhance understanding.

The work is under way. Electronic circuits that simulate the operation of nerve cells have already been created—and conceptual models of the neural network are being constructed.

Alexander Graham Bell's interest in deafness and hearing led to the invention of the telephone. Bell Laboratories' current explorations in binaural sound may well lead to important new advances in the transmission of speech and music.

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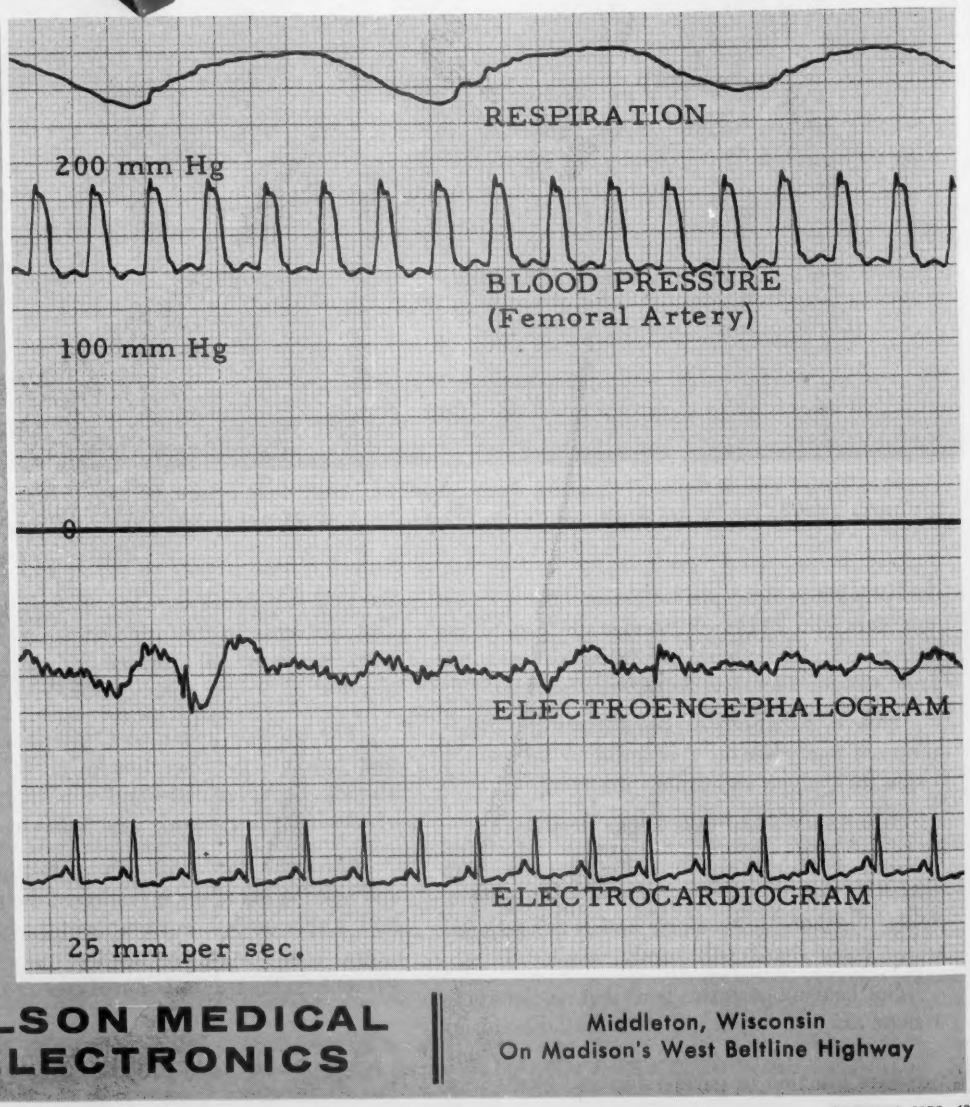

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Weight of Expert Testimony

In carrying out its mission to prevent "unfair methods of competition in commerce, and unfair or deceptive acts or practices in commerce," the Federal Trade Commission often encounters conflicts between the testimony of experts and that of users about the merits of a product. Such a conflict has occurred in the case of the Evis Water Conditioner, which is an oversized galvanized cast iron, or bronze, pipe coupling with an integrally cast center post. The device is, according to the Evis Manufacturing Company, designed to be installed in the supply pipe to improve the quality of water for domestic or industrial use. The company advertises that the conditioner has the following beneficial effects, among others: It will solve hard water problems; reduce the cost of heating water; remove grease; prevent or remove scale; prevent, reduce, or eliminate scum, rust stains, and corrosion; retard the pitting of metal; leach out alkali and salts; reduce the amount of water required for irrigation; improve the texture or structure of soil; and increase the production of agricultural products.

The Federal Trade Commission regarded these claims as false and misleading and issued a complaint on 5 February 1954. After holding extensive hearings to collect testimony from both users and scientists, the FTC hearing examiner dismissed the complaint on 26 April 1956, despite the fact that laboratory and field tests failed to substantiate any of the claims made for the conditioner. He concluded, largely on the basis of the testimony of users, that "it appears that we may here be confronted with a device operating upon a principle unknown to or unrecognized by present-day science" and added, "the scientists admitted that they did not understand the theory upon which the Evis Water Conditioner purports to operate." It is fair to add that neither the inventor nor the users claimed to understand it either.

On 20 December 1956, the FTC remanded the case to the hearing examiner for another go-round. On 30 June 1958, he again decided that the complaint should be dismissed. The Commission was unwilling to accept this recommendation and on 3 April 1959, in an opinion written by Commissioner Sigurd Anderson, stated that the hearing examiner had been in error in dismissing the complaint and ordered the Evis Manufacturing Company to discontinue making false claims.

Anderson pointed out that the results of tests run in laboratories or practical installations were "almost wholly adverse to the Evis Water Conditioner," while the evidence in favor of the conditioner was "almost entirely connected with the testimony of users." The opinion noted that the evidence from users was not obtained under scientifically controlled conditions. Perhaps the most significant conclusion was this: "The scientific evidence in the record almost entirely supports the allegations of the complaint. The user evidence, in these circumstances, is of relatively little value."

This opinion sets no precedent: the Commission has made similar distinctions before. But the opinion does reaffirm the value of expert testimony and the controlled experiment as legal evidence—a reaffirmation that will hearten those who believe that decisions affecting the public interest should be made on rational grounds.—G.DuS.

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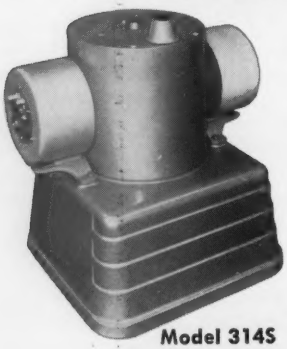

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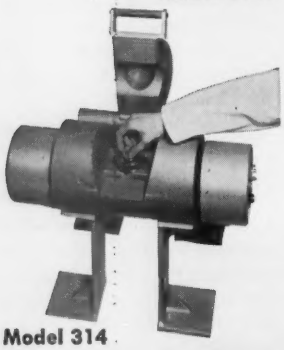

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Atmospheric Aspects of Strontium-90 Fallout

Fallout evidence indicates short stratospheric holdup time for middle-latitude atomic tests.

E. A. Martell

The production of fission-product strontium-90 in nuclear weapon tests, its world-wide distribution in fallout, and its possible biological consequences are matters which have received increasing public attention over the past several years. The particular concern with Sr^{90} stems from its high fission yield, its long half-life of 28 years, and its chemical similarity to calcium, which it follows from the soil, through vegetation and dairy products, to its eventual incorporation into human bone.

The physical and biological distribution of Sr^{90} activity was initially investigated on a world-wide basis in studies carried out by the University of Chicago Sunshine Project (*1*). The results of this work and related studies have been extensively discussed by W. F. Libby (*2–5*). Methods of analysis and summaries of the experimental results have been presented elsewhere (*6–8*). For a comprehensive treatment of the general aspects of radioactive fallout, the reader is referred to two excellent summaries (*9–10*).

One of the important areas of uncertainty in our knowledge of Sr^{90} fallout is the atmospheric history of Sr^{90} debris and the consequent world-wide distribution of this debris. Experimental evidence (*2, 8*) has indicated that, aside from local fallout from surface bursts, debris from small nuclear weapons is circulated in the lower atmosphere, is confined to the hemisphere in which it was produced, and exhibits a mean atmospheric residence time of about 1 month. By contrast, the debris from weapons of megaton yield is largely injected into the stratosphere, exhibits a long stratospheric residence time, and may have world-wide distribution. The rate and extent of stratospheric mixing and the rate and mechanism of transport of stratospheric debris through the tropopause into the lower atmosphere are not completely understood. Details of the mixing and scavenging of the Sr^{90} debris in the troposphere have not been fully explained, although it has been well established (*3, 8, 11*) that precipitation plays the dominant role in the deposition of Sr^{90} debris.

In view of our limited knowledge of large-scale atmospheric circulation, and in view of the inherent experimental difficulties in the synoptic evaluation of either the atmospheric distribution or the surface distribution of Sr^{90} debris on a world-wide basis, the present stratospheric burden of Sr^{90}, the deposition rate and the consequent ground distribution of Sr^{90} can be only crudely estimated. It is the object of this article to review some of the experimental evidence relating to the nature and atmospheric history of Sr^{90} debris and to discuss a number of experimental uncertainties and special considerations which affect the interpretation of world-wide fallout.

The author is a member of the Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass.

Production of Strontium-90

The half-life of Sr^{90} has been well established as about 28 years (*12, 13*). The corresponding fission yield of Sr^{90} from slow-neutron fission of U^{235} ranges from 5.4 to 5.8 percent (*13, 14*); the uncertainty with respect to the absolute value is 10 to 20 percent. When 1.0×10^{12} calories is taken as the energy equivalent of 1 kiloton of TNT and 5.6 percent, as the U^{235} fission yield of Sr^{90}, the production of Sr^{90} is 1.14 grams per kiloton, corresponding to 146 curies per kiloton. Yields of Sr^{90} will be substantially lower for fissionable materials of mass greater than 235 and will be further modified by the neutron energy spectra of nuclear weapons, with reduced yields for higher neutron energies. The amount of Sr^{90} produced by nuclear weapons is usually taken as 100 curies per kiloton of fission energy release. It is unlikely that the uncertainty in this value exceeds 30 percent.

The Sr^{90} activity is produced in the mass-90 fission chain as follows:

$$Kr^{90} \xrightarrow{33\ sec} Rb^{90} \xrightarrow{2.7\ min} Sr^{90} \xrightarrow{28\ yr} Y^{90} \xrightarrow{64.6\ hr} Zr^{90}(stable)$$

Estimates of the most probable charge distribution for U^{235} thermal-neutron fission (*13*) indicate high independent yields only for Kr^{90} and its very short-lived precursor, Br^{90}, with independent yields of Rb^{90}, Sr^{90}, and Y^{90} contributing only about 15, 0.1, and 10^{-4} percent of the total chain yield, respectively. The distribution of independent yields for the mass-90 chain for nuclear weapons will vary somewhat with mass of fissioning nuclide and with neutron energy.

Adams, Farlow, and Schell (*15*), in a detailed discussion of bomb debris con-

densation and of the physical and chemical characteristics of local fallout particles, give evidence for the occurrence of spherical radioactive particles as small as a few tenths of a micron in diameter for surface shots over coral and of similar particles as small as 0.01 micron in diameter for surface shots over sea water. They also give evidence for the isotopic enrichment of Ba^{140} and Sr^{89} on fallout particles which condense after a relatively long time interval has elapsed.

For weapons of low yield, independent yield distribution and condensation rate clearly indicate that Sr^{90} and other daughter products of volatile and gaseous fission products condense later than most of the vaporized materials in the fireball. For high-yield shots the times of debris condensation and Sr^{90} formation are more nearly comparable, and less fractionation of gaseous precursor products is to be expected. However, in this case condensation takes place at stratospheric altitudes following extensive cloud dilution, and this leads to the formation of particles less than 1 micron in diameter. The long stratospheric storage time that is observed for stratospheric debris is perhaps the most convincing evidence that the particles are of submicron size. It is indicated that Sr^{90} produced in weapon tests is to a large extent concentrated in very fine particles which can remain airborne for sufficiently long periods to make extensive distribution over the world possible.

The delayed condensation of Sr^{90} suggests that, except possibly in the case of high-yield surface bursts over silicate soils, the chemical form of the Sr^{90} activity is strontium oxide. During its subsequent circulation in air, the strontium oxide would be readily converted to the hydroxide by the action of atmospheric water vapor. Exposure to atmospheric carbon dioxide would result in slow, partial conversion of the hydroxide to carbonate. Experimental verification of the chemical nature of Sr^{90} debris would be complicated by the attachment of the very small Sr^{90} particles to larger particles of bomb debris and to natural particulate and liquid aerosols in the atmosphere. It has been observed (*8*) that the Sr^{90} activity deposited in rains is substantially all in water-soluble form and thus is generally available for uptake in the biosphere.

Libby (*5*) has provided estimates of the cumulative amount of Sr^{90} introduced into the stratosphere and troposphere for all United States, United Kingdom, and Soviet nuclear tests up to December 1957. Total stratospheric injection is estimated (*5*) as 3.6 megacuries of Sr^{90}, about two-thirds of this amount resulting from United States tests in the Pacific and one-third from Soviet tests. In addition, nearly 0.6 megacurie is estimated to be the total distributed as tropospheric debris. These estimates were made on the assumption of a local fallout of 80 percent for surface land shots and 20 percent for surface water shots. The remaining 20 and 80 percent, respectively, was assigned to the stratosphere for shots with total energy release of 1 megaton or more and to the troposphere for smaller shots.

Such estimates are subject to the several uncertainties with respect to Sr^{90} fission yield discussed above, and uncertainties in estimation of the total fission energy release for the various nuclear devices tested and in the determination of the fraction of Sr^{90} production which falls out locally. Obtaining essential information about Soviet nuclear tests and determining the local fallout fraction for high-yield surface shots in the Pacific test areas entail obvious difficulties. Estimates of the total amount of Sr^{90} which has been distributed as world-wide contamination may, therefore, be in error by as much as a factor of 2.

Fallout Models

Several alternative interpretations of Sr^{90} fallout observations have been proposed, by Libby (*2, 3, 5*), Stewart *et al.* (*11, 16*), and Machta (*10, 17*), respectively. The principal features of the experimental data which require explanation are the strong peak in cumulative Sr^{90} deposition in the middle latitudes of the Northern Hemisphere and the sharp increase in Sr^{90} deposition rate which has been observed in the spring in each of the past several years.

According to Libby's model (*2, 3, 5*), Sr^{90} debris which is injected into the stratosphere is uniformly mixed over both hemispheres in the first year or two following injection and exhibits an average storage time of 10 ± 5 years. Libby proposes that stratospheric debris will be distributed nearly uniformly over the world except for differences due to variations in rainfall. Tropospheric debris from submegaton weapons, distributed in a narrow latitude band for each test site, is thought to account for both the high mid-latitude deposition and the observed spring peaks in Sr^{90} fallout.

Stewart *et al.* (*11*) conclude from measurements of the ratio of Sr^{89} to Sr^{90} in rains that since 1954 nearly all Sr^{90} deposited at places remote from test sites has been derived from delayed fallout of stratospheric debris. They also indicate that the seasonal variation in concentration of Sr^{90} in rain is in step with a similar variation in the concentration of the lower stratosphere. These authors suggest that the results are consistent with the circulation model proposed by Brewer (*18*) and Dobson (*19*).

Brewer explains the observed distribution of water vapor in the lower stratosphere as being the result of air entering the stratosphere near the equator, moving northward, and sinking into the troposphere in temperate and polar regions. Dobson explains the spring rise of ozone concentration in the lower atmosphere at high latitudes as being due to the sinking of a cold air mass which forms above the winter pole during the late winter. Stewart and his associates attribute the high peak of Sr^{90} deposition in the middle latitudes of the Northern Hemisphere to a Brewer mode of circulation with selective downward mixing of stratospheric debris at middle latitudes. The spring peak in the Sr^{90} deposition rate is attributed to Sr^{90}-rich air at higher stratospheric levels, carried down in the same manner as ozone.

Machta (*10, 17*) has discussed some of the meteorological factors involved and has raised a number of objections to both proposed models. He favors a shorter stratospheric residence time of about 5 years and, like Stewart, attributes the high level of deposition in middle latitudes of the Northern Hemisphere and the spring increase in deposition rate to stratospheric fallout, considering selectivity with respect to latitude and season of deposition to be due to meteorological factors.

An alternative interpretation of the Sr^{90} fallout observations is presented below, following discussion of some of the principal features and limitations of the experimental evidence.

Concentrations of Strontium-90 in Air

A number of large-volume surface air samples from several Northern Hemisphere locations were collected by the Naval Research Laboratory and analyzed for Sr^{90} at the University of Chicago (*8*). Measurements were made of collections from Washington, D.C.; Kodiak, Alaska; Port Lyautey, French Morocco; and Yokosuka, Japan. The results are summarized in Fig. 1. Each point of Fig. 1 represents the volume-weighted average of only several days' collection dur-

ing any one month at each location and thus may not provide a very reliable measure of average monthly air concentration. For locations other than Washington, D.C., the data may be in error by as much as 50 percent, due principally to uncertainty with respect to volume. The relative concentration values at each location are reasonably accurate.

These data exhibit several interesting features. There is a roughly exponential rise in concentration of Sr^{90} over the 4-year period of observation and a general equivalence in range of Sr^{90} concentration at all four locations. The 1952 data for Kodiak, Alaska, show contribution from the spring 1952 Nevada tests, followed by complete absence of Sr^{90}—a typical finding for contamination that is purely tropospheric. The data for the period 1953 through 1955 for all four locations demonstrate the build-up of delayed fallout from the stratosphere following the November 1952 Ivy test and the spring 1954 Castle tests, with some superimposed contribution of tropospheric debris from intermittent small-weapon tests. The higher concentrations observed for Washington and Port Lyautey during the spring of 1955 may be due to the spring 1955 Nevada tests or to other production or circulation factors.

Data for total fission-product beta activity for surface air at Washington, D.C., furnished by I. H. Blifford, Jr. (*20, 21*), are presented in Fig. 2, together with data on Sr^{90} concentration for the same location. The plotted fission-product activity data have not been corrected for decay. Mixed fission products decay exponentially with time, with approximately an order of magnitude decrease in activity corresponding to a sevenfold increase in age of the fission products. Thus, the observed fission-product activity levels are quite sensitive to considerations of production date and rate of arrival. The peak fission-product concentrations shown in Fig. 2 provide, with this complication, a history of tropospheric contamination from small-weapon tests. Peak heights for a given test area reflect tropospheric injection amounts, modified substantially by tropospheric circulation and mixing factors. The lower peak heights for Russian tests as compared with Nevada tests are due to greater decay and dilution due to mixing, consistent with later arrival times. The very low concentrations observed following high-yield United States tests at the Pacific Proving Grounds reflect the limited extent of early fallout contamination from these tests.

When the steep slope of the fission-product activity curve following small-weapon tests is corrected for decay, the curve provides a measure of the dilution and removal rate for tropospheric contamination. Using similar data for tropospheric air samples and assuming virtually complete lateral and vertical diffusion several weeks after production date, Stewart, Crooks, and Fisher (*16*) have estimated a mean tropospheric residence time of about 1 month. Appreciable continued lateral diffusion would correspond to longer residence times. Considerations of particle size and meteorological factors which affect diffusion and washout suggest the tropospheric residence time may be quite variable.

The data for fission-product activity given in Fig. 2 indicate essentially complete removal of tropospheric contamination between tests before November 1952. Following the November 1952 Ivy test and the spring 1954 Castle test, the minimum mixed fission-product concentrations observed can be attributed to the slow downward mixing of fission products from the stratosphere. Curve *A* (Fig. 2) is approximately fitted to the data and represents the slow mixing of Operation Castle stratospheric contamination into surface air at north temperate latitudes. Curve *B* is similarly constructed, the same buildup with time that followed Ivy and Castle being assumed and the Ivy contribution being based on the January and February 1954 fission-product activity data. Comparison of curves *A* and *B* indicates the ratio of the post-Castle and post-Ivy stratospheric inventories to be about 5 or 6 to 1. When correction for decay is made for curve *A*, the transport of Castle debris to surface levels at latitude 39° north is shown

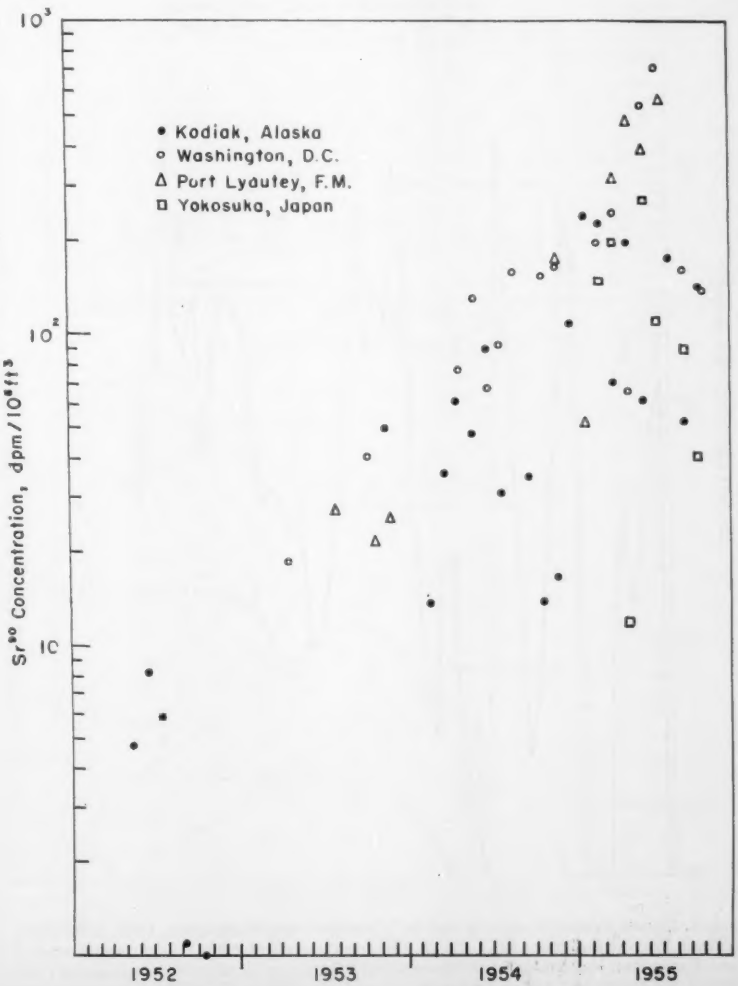

Fig. 1. Concentration of Sr^{90} in surface air.

to be negligible in the first three months and, subsequently, to increase continuously over a period of about one year.

The data for concentration of Sr^{90} in air for Washington, D.C. (Fig. 2, curve *C*) are higher by factors of 2 to 3 than Sr^{90} values computed from the resolved stratospheric component of fission product activity data (Fig. 2, curve *A*). The difference equals or exceeds the combined uncertainties in sampling and analysis. This result lends credence to the separation of the fission product data (Fig. 2) into tropospheric and stratospheric components, since the discrepancy can be reduced only by an upward revision of the stratospheric contribution (curves *A* and *B*).

The resolution of stratospheric and tropospheric components of the fission-product beta-activity data (Fig. 2) makes it possible to estimate the contribution of tropospheric contamination to total Sr^{90} fallout during this early period. If average tropospheric contamination arrival times at Washington, D.C., are assumed to be 1 week for Nevada tests and 2 weeks for Soviet tests, and if 30 days is taken as the half-time of removal due to further dilution and deposition, it is estimated that tropospheric fallout accounts for less than 50 percent of the total Sr^{90} fallout in 1953 and for less than 10 percent of that in 1954 and the first 10 months of 1955.

Blifford *et al.* (*20*) have presented records of the average monthly fission-product beta activity of the surface air, for the period 1950 to 1955, for five locations in the Northern Hemisphere ranging from Subic Bay, Philippine Islands (14°45′N), to Kodiak, Alaska (57°30′N). These records show responses to Nevada and Soviet tests at all locations, indicating that tropospheric debris is very widely distributed over the hemisphere. Records for Subic Bay and for Pearl Harbor, Hawaii, show peak responses following the Ivy and Castle tests which do not exceed those observed in Washington, D.C., following Nevada tests. If the yield of the Pacific tests is assumed to be greater by about two orders of magnitude, it is evident that initial tropospheric contamination from multimegaton weapon tests, excluding local fallout, amounts to only about 1 percent of the total fission production.

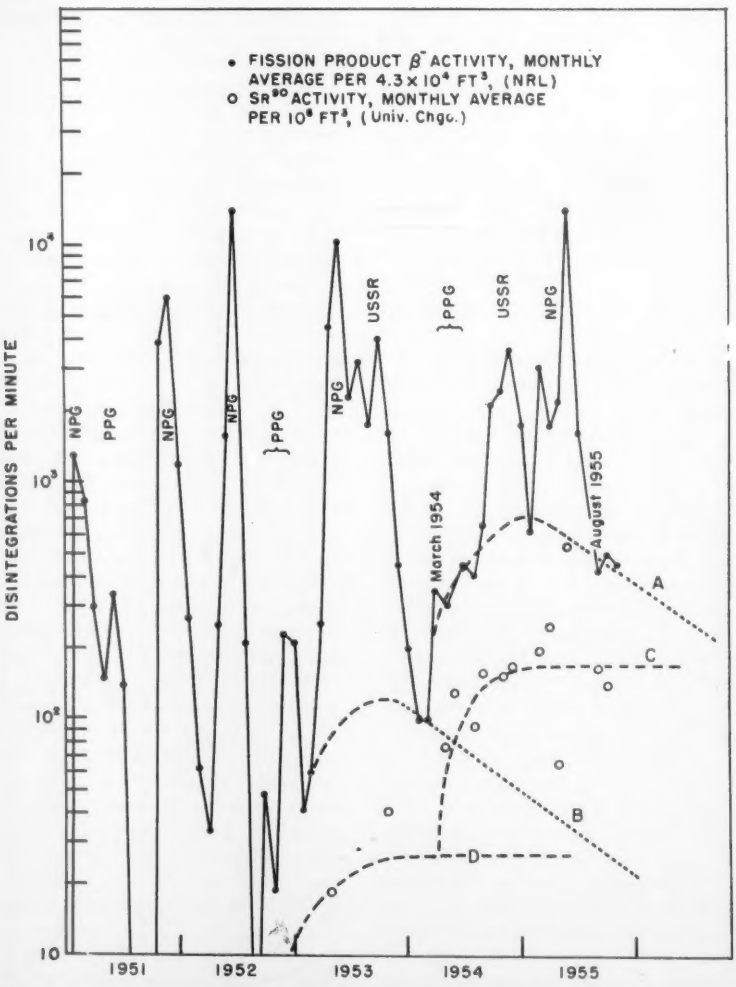

Fig. 2. Fission-product-β^- activity and Sr^{90} in surface air, Washington, D.C., from NPG, Nevada Proving Grounds; PPG, Pacific Proving Grounds; USSR, Soviet tests. Curves *A* and *B* represent the approximate stratospheric component of fission-product activity following the Castle and Ivy nuclear tests, respectively. Curves *C* and *D* represent the Sr^{90} concentration for corresponding periods.

Precipitation Data

The cumulative deposition of Sr^{90} in rains and snows at Chicago (*6–8*), Pittsburgh (*8, 22*), New York City (*22*), and Milford Haven (Wales) (*11*) is summarized in Fig. 3. The Chicago and Milford Haven deposition curves have been normalized in conformity with the observed cumulative burden of Sr^{90} of soils in the two areas. The Pittsburgh and New York City data are fitted approximately to the 1954 Chicago levels. Results for two New York City soils (*22*) are included for comparison. Altogether, these rainfall data provide a nearly complete history of the deposition of Sr^{90} in the middle latitudes of the Northern Hemisphere. Other areas at these latitudes which have similar fallout histories show considerable variation in amount of Sr^{90} accumulated, due principally to differences in annual rainfall. Other factors that affect Sr^{90} deposition include seasonal distribution of rainfall, type of rainfall, pattern of regional air circulation, and proximity to nuclear test sites.

The rainfall data (Fig. 3) indicate that only a small—perhaps a negligible—fraction of present levels of Sr^{90} fallout was deposited before the advent of large-scale nuclear tests. A substantial increase in annual Sr^{90} fallout occurred in each successive year up to the end of 1957. An important feature of the rainfall data is the sharp increase in Sr^{90} deposition rate in the spring—an increase which accounts for a large proportion of the total fallout for each year.

This spring increase has been attributed by Libby (*2, 5*) to tropospheric contamination from submegaton weapon tests; by Stewart *et al.* (*11*) and Machta (*17*), to more rapid downward mixing of stratospheric air at middle and higher latitudes in the spring. I submit the alternative view that the spring increases are due largely to Soviet tests of intermediate- and high-yield weapons which have injected debris into lower and intermediate levels of the stratosphere—debris which exhibits relatively short stratospheric residence times. I attribute the substantial spring rise that has occurred in each of the past 3 years principally to the immediately preceding fall and winter series of Soviet tests. Substantial evidence to support this interpretation is available and is discussed in subsequent sections of this article.

The wide range in the Sr^{90} burden observed for soils in northern hemisphere locations of equivalent annual rainfall and latitude for some time masked the dominance of rainfall as a factor in Sr^{90} deposition. The low Sr^{90} content of soils (*3, 8*) in low-rainfall areas was the first evidence that rainfall is the controlling factor. Brawley, California, with less than 2 inches of annual rainfall, held less than 0.6 millicurie of Sr^{90} per square mile in the topsoil in January 1956. This is less than one-tenth the levels concurrently observed in high-rainfall areas of similar latitude. At Antofagasta, Chile, where it almost never rains, the January 1956 Sr^{90} level in soil was 0.02 millicurie per square mile—about 0.01 of the concurrent level in high-rainfall areas of the Southern Hemisphere. Such evidence convincingly demonstrates that the gravitational settlement of dry particles is a negligible factor in the world-wide fallout of Sr^{90}.

Results for the Mediterranean area soils (Fig. 4) provide striking evidence of the dependence on rainfall of the Sr^{90} level in soils. The remarkable rainfall correlation for this set of soils was first pointed out by L. T. Alexander (*23*). These Mediterranean lands all receive the same seasonal distribution of rainfall, with a marked winter maximum and extremely dry summers. In general, the rainfall over the whole area is derived from air masses of similar mixing history. Similar correlation of total Sr^{90} deposition with total rainfall has been observed in other limited geographical areas (*24, 25*). It is indicated that within a given limited geographical region the average Sr^{90} concentration in rains will be approximately constant. It has also been shown (*8, 11*) that for individual rains at a given location, the specific concentration of Sr^{90} decreases with increasing amounts of rain. Thus, within areas showing total Sr^{90} deposition proportional to total rainfall, a location which received twice as much Sr^{90} fallout as another must have experienced about twice as many rains of the same general type and intensity.

The data given in Fig. 4 for the Southern Hemisphere show a roughly similar relationship between Sr^{90} deposition and total rainfall. It is quite evident from data (*2, 7, 8*) for South American soils and Antarctic snows that delayed stratospheric fallout has been almost exclusively the source of Sr^{90} fallout in the Southern Hemisphere. Two soils from Belo Horizonte, Brazil, held 0.11 and 0.17 millicurie per square mile, respectively, in March 1954. Nearby areas of

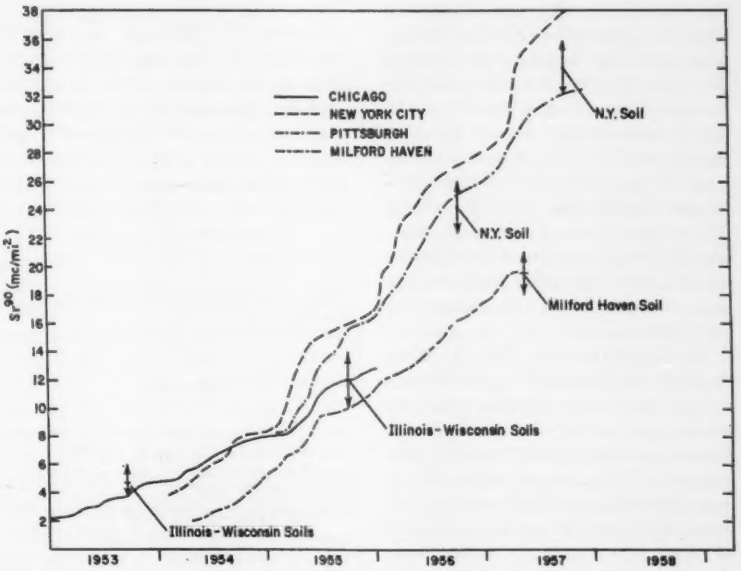

Fig. 3. Cumulative Sr^{90} deposition in rain.

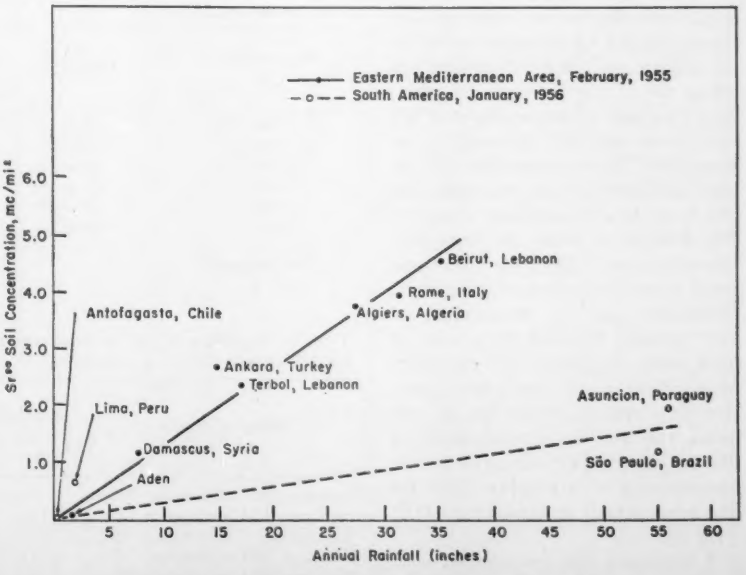

Fig. 4. Concentration of Sr^{90} in soil versus annual rainfall.

similar high rainfall at São Paulo, Brazil, and Asunción, Paraguay (Fig. 4), show 1.2 and 2.0 millicuries, respectively, per square mile in January 1956, indicating an intervening annual Sr^{90} fallout rate of nearly 1 millicurie per square mile. A somewhat lower precipitation rate has been estimated (*2*) from snow-core data from Antarctica (*7*) for the same period. Recent results (*5, 22*) for rain collections in the Southern Hemisphere indicate about 1 to 2 millicuries per square mile per year as the 1957 rate of Sr^{90} fallout.

The results (*8, 26*) of Sr^{90} assay of snow cores and surface snows from polar areas are presented in Tables 1–3. Greenland snow-core samples were obtained from Site II of the Snow, Ice, and Permafrost Research Establishment. This site provides reliable annual precipitation layers. The dating of layers has been checked by measurement of density and oxygen isotope-ratio profiles, both of which show seasonal variation. Additional snow cores and fresh precipitation samples from both polar areas are currently being collected and analyzed for Sr^{90} (*26*).

The Greenland core (Table 3) shows negligible Sr^{90} deposition up to the summer of 1953, indicating that essentially no tropospheric fallout occurred in this latitude and that at least 9 months' mixing time was required for arrival of stratospheric debris from the November 1952 Ivy test. If about 9 months is assumed to be the time required for stratospheric debris from shots at the equator to arrive in Antarctica, the Admiral Byrd Bay core (Table 2) can be approximately dated. Post-Ivy and post-Castle precipitation concentrations are indicated to be about 0.85 and 3.8 disintegrations of Sr^{90} per minute per liter for Greenland and about 0.6 (Table 2, 0.5 to 1.5 years) and 3.4 (Table 1) disintegrations of Sr^{90} per minute per liter in Antarctica, respectively. Direct comparison of the data for Greenland and Antarctica cannot be made with confidence because of the difficulty of dating the cores from Antarctica and because local and seasonal factors may affect both the depth distribution and the concentration of Sr^{90} in snows. However, the two sets of data show comparable Sr^{90} concentration, and the ratio of post-Castle to post-Ivy Sr^{90} levels is similar for the two areas. The ratios are also comparable to the ratio observed for average surface air concentration of stratospheric Sr^{90} for the same periods at Washington, D.C. (Fig. 2).

F. Begemann (*27*) has reported average levels of tritium, from cosmic rays, of 12.6 ± 1.0 and 16.8 ± 1.5 tritium atoms, respectively, per 10^{18} hydrogen atoms for Site II, Greenland, and for Antarctica. If the average amounts of precipitation in Antarctica and in the Arctic are assumed to be inversely proportional to the levels of tritium from cosmic rays, the Arctic would thus appear to have a 33 percent higher annual precipitation than the Antarctic. This leads to the conclusion that deposition of debris from the Ivy and Castle Pacific tests is about 1.5 to 2 times higher in the Arctic than in Antarctica. The values for the Arctic may include some contribution from Soviet tests. The difference may also be due to the fact that the equatorial tests were conducted at 11° north latitude and that hemispheric distribution was therefore unbalanced. Recent collections from both polar areas, including dated cores from Antarctica, should make more accurate comparison possible.

Age of Debris

Measurements of the ratio of Sr^{90} activity to total fission product activity and to the activity of Sr^{89} and other isotopes have been carried out (*11, 25*) in order to distinguish the relative contribution of tropospheric and stratospheric debris to total Sr^{90} deposition and thus to try to account for the sharp increase in the rate of Sr^{90} deposition in the spring (Fig. 3). Results of measurements of Sr^{89} and Sr^{90} in rains at Milford Haven reported by Stewart *et al.* (*11*) are reproduced in Fig. 5. Assuming a mean age of 35 days for tropospheric debris from small weapon tests and further assuming that all Sr^{89} is derived from such tests, Stewart (*11*) estimates that, at most, 5 and 12 percent, respectively, of the total Sr^{90} fallout in the spring of 1955 and 1956 was tropospheric debris. He then concludes that practically all Sr^{90}

Table 1. Deposition of Sr^{90} in surface snow from Antarctica, collected in January–February 1955.

Location	Depth (in.)	Sr^{90} content (disintegration/min/lit.)	Sr^{90} fallout increment* (mc/mi^2)
Little America III (78°S, 170°W)	0 to 8	3.2 ± 0.3	0.31
Little America III (½ mile to the east)	0 to 8	3.1 ± 0.7	0.30
Atka Bay (70°S, 8°W)	0 to 8	5.3 ± 0.5	0.51
Admiral Byrd Bay (69°S, 1°W)	0 to 12	2.0 ± 0.2	0.29
Average		3.4 ± 0.5	

* Density, 0.4.

Table 2. Deposition of Sr^{90} in snow core from Admiral Byrd Bay (69°S, 1°W), collected 19 February 1955.

Estimated age (yr)	Depth (in.)	Sr^{90} content (disintegration/min/lit.)	Sr^{90} fallout rate* ($mc/mi^2/yr$)
0 to 0.25	0 to 12	2.0 ± 0.2	1.2
0.25 to 0.50	12 to 24	1.7 ± 0.2	1.0
0.50 to 0.75	24 to 36	0.48 ± 0.04	0.28
0.75 to 1.0	36 to 48	0.90 ± 0.06	0.52
1.0 to 1.25	48 to 60	≤ 0.48	≤ 0.3
1.25 to 1.5	60 to 72	0.29 ± 0.03	0.16

* Average density, 0.42.

Table 3. Deposition of Sr^{90} in snow core from the Snow, Ice, and Permafrost Research Establishment's site II, in Greenland (77°30′N, 50°30′W), collected 13 September 1956.

Period of sample	Depth (in.)	Density	Sr^{90} content (disintegration/min/lit.)	Sr^{90} fallout rate ($mc/mi^2/yr$)
Summer 1955 to summer 1956	0 to 49	0.36	3.8 ± 0.2	2.0
Summer 1954 to summer 1955	49 to 98	0.40	1.34 ± 0.16	0.79
Summer 1953 to summer 1954	98 to 126	0.41	0.85 ± 0.08	0.29
Summer 1952 to summer 1953	126 to 169	0.41	0.05 ± 0.12	0.03
Summer 1951 to summer 1952	169 to 206	0.42	0.01 ± 0.08	0.00

fallout since 1954 has been derived from old stratospheric debris and that the spring peaks are due to more rapid downward mixing of stratospheric air during the spring.

The assumptions made in Stewart's analysis warrant further consideration. The mean residence time for tropospheric debris may vary appreciably with latitude, season, and weather pattern. However, the range of possibilities is unlikely to alter the conclusion that tropospheric debris from small weapon tests accounts for only a small fraction of the total Sr^{90} fallout. The assumption that the increase in Sr^{89} activity (Fig. 5) is due to tropospheric contamination from small weapon tests appears reasonable at first sight, and is in accord with the widely accepted view that stratospheric debris exhibits a mean residence of 5 to 10 years. However, each increase in rate of Sr^{90} deposition (Fig. 5) appears to be accompanied by a relatively greater increase in Sr^{89} deposition, indicating contribution from recent tests. If these substantial increases in both Sr^{89} and Sr^{90} are related, an explanation other than that of small weapon tests or seasonal mixing effects is needed. A reasonable possibility is that the Sr^{89} is largely of stratospheric origin and that each peak of deposition involves debris injected into the stratosphere only a few months earlier. It should be noted that Soviet tests of high-yield devices have been conducted in the fall or winter of each of the past three years, preceding the three periods of most intense Sr^{90} fallout at north temperate latitudes.

Results of measurements of Sr^{89} and Sr^{90} for rains in the United States, carried out by the Atomic Energy Commission's Health and Safety Laboratory and reported by Collins and Hallden (*25*), are presented in Table 4. The calculated production dates (Table 4, column 4), computed from the average monthly concentration data for March, April, May, and June, clearly suggest the fall 1955 Soviet tests as a prominent source. It would be quite a coincidence if the apparent age of a mixture of fresh tropospheric and old stratospheric contamination should remain so nearly constant for four months. The Sr^{89}/Sr^{90} ratios for rains in Milford Haven (Fig. 5) show the same trend during this period, with values about one-half those observed for rains in the United States (Table 4). The difference in ratios may be due to errors in analysis or to real differences in the relative contribution of older stratospheric debris to the Sr^{90} fallout in these two regions. In view of the methods of analysis (*25, 28*) and the magnitude of the Sr^{89}/Sr^{90} ratios (Fig. 5 and Table 4), it is thought that analytical errors should not introduce more than a 50 percent error in ratios, amounting to about a 1-month variation in apparent age.

Table 4. Age of debris determined from Sr^{89}/Sr^{90} ratio in rains in the United States, March–July 1956.

Sampling month	Av. Sr^{90} deposition (mc/mi²/mo)	Av. Sr^{89}/Sr^{90} ratio	Calculated production date
March	1.2	22	Sept. 1955
April	1.1	9.7	Aug. 1955
May	1.6	9.3	Sept. 1955
June	1.0	7.0	Oct. 1955
July	1.5	29	Feb. 1956

The foregoing suggestion that the winter-spring 1956 Sr^{89} concentration in rains is largely stratospheric in origin implies that the tropospheric contribution of Sr^{90} from small weapon tests is even lower than Stewart's estimates. Blifford *et al.* (*20*) show appreciable mixing of debris from Nevada and Soviet tests over the whole range of latitudes from 15° to 57°N. A cloud height of about 77,000 feet for a 1-megaton explosion has been reported (*29*). Tropopause heights range from about 55,000 feet at the equator to 30,000 feet at high latitudes. It is indicated that tropospheric contamination results only from surface or low-altitude nuclear detonations of less than about 100 to 200 kilotons in yield; if this is true, downward revision of estimates of tropospheric contamination is necessary. The reduced inventory and widespread distribution of tropospheric debris are consistent with the supposition that tropospheric contamination constitutes only a small percentage of total Sr^{90} fallout.

Results of recent experiments (*26*) support the view that stratospheric contamination from high-yield Soviet tests appears in high concentration at lower stratospheric levels and exhibits relatively short stratospheric residence time. Air-filter samples collected from lower stratospheric levels in the Northern Hemisphere during April 1958 showed very high concentrations of short-lived fission products at middle latitudes and only old fission products at low latitudes. The Ba^{140}/Sr^{90} ratios for a series of 15 individual rains in Bedford, Massachusetts (*26*), in the period from 2 to 8 weeks following the last announced Soviet test in March 1958, decreased regularly with the 12.8 day half-life of Ba^{140}. Since the Sr^{90} deposition rate was slowly increasing during this period, the only reasonable physical interpretation appears to be that even the short-lived Ba^{140} activity is of stratospheric origin. Rapid downward mixing of stratospheric debris from Soviet tests is indicated.

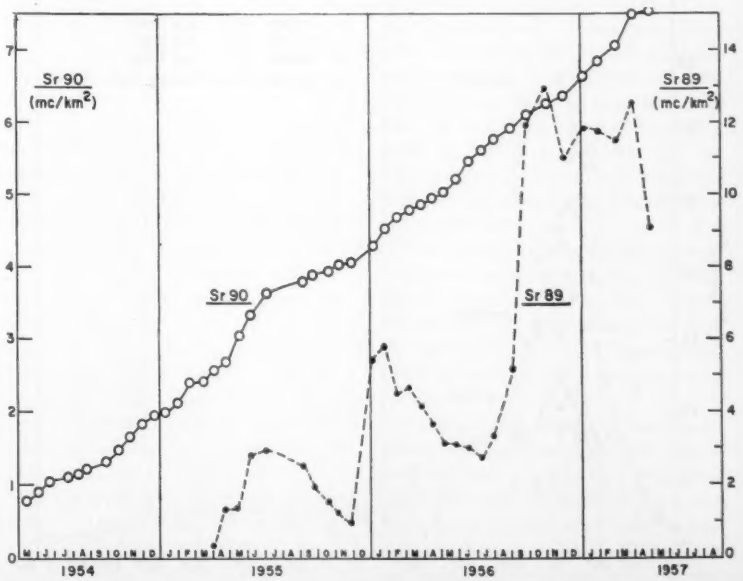

Fig. 5. Cumulative deposition of Sr^{89} and Sr^{90} at Milford Haven, Wales. [According to N. G. Stewart (*11*)]

Surface Distribution

The approximate world-wide distribution of Sr^{90} over land areas in mid-1956, based on Health and Safety Laboratory soil measurements (*22*), is presented in Fig. 6. This representation somewhat overemphasizes United States levels in order to show recent annual changes in the levels at north temperate latitudes where adequate soil data were available. These soils were sampled to a depth of 6 inches, and the Sr^{90} was quantitatively extracted with hydrochloric acid before assay. A few soils from areas of abnormally low or high precipitation were omitted in order that the distribution might be reasonably representative. The Arctic and Antarctic levels of 1.8 and 1.2 millicuries per square mile, respectively, for mid-1956 are based on the data in Tables 1–3 and assume mean annual precipitation of 10 and 8 inches of water equivalent, respectively, in the Arctic and in the Antarctic.

The Southern Hemisphere distribution includes representative soil data from South America, South Africa, Australia, and New Zealand. Variations in soil levels appear to correlate roughly with total annual rainfall, the principal cause of variation in observed Sr^{90} burden (Fig. 4). Other variations are at least partly due to errors in sampling and analysis and to differences in sampling times. Except for the lower deposition in Antarctica, there is no striking variation in latitudinal distribution that can be related to features of the general atmospheric circulation. Since atomic tests in the Southern Hemisphere have been very limited in number and yield, fallout in the Southern Hemisphere is essentially all derived from stratospheric debris. The 1956 levels for the Southern Hemisphere may be accounted for by United States equatorial tests alone.

In the Northern Hemisphere the striking feature is the heavy fallout in the middle latitudes. Comparable high levels are observed in northern United States, southern Canada, and northern Europe. Within a limited geographical area, the cumulative level in soil is approximately proportional to total rainfall. Large variations for areas of similar latitude and annual rainfall occur as a result of seasonal distribution of rainfall in relation to the spring peak in deposition rate. There is also a striking variation in deposition with latitude in relation to the zone of entry for stratospheric debris from Soviet tests. Proximity to small weapon test sites, variations in type of rainfall, and circulation features have some additional effect on distribution.

Discussion and Conclusions

It is inferred from considerations of the age of debris and other evidence discussed above that the spring peak in Sr^{90} fallout (Fig. 3) may involve a substantial contribution from stratospheric debris of short residence time injected during the immediately preceding Soviet test series. This possibility is strongly reinforced by consideration of alternative interpretations. Estimates based on Sr^{89}/Sr^{90} ratios and other evidence discussed above indicate that the Sr^{90} contribution from tropospheric debris following small weapon tests is minor. Selective downward mixing of old, and thus well-mixed, stratospheric debris during the late winter and spring (a theory in accord with Dobson's interpretation of the ozone data) may also be questioned as an explanation for the spring peaks in Sr^{90} deposition rate. If seasonal variation in downward mixing of stratospheric Sr^{90} debris were an important factor independent of considerations of production, the effect should be evident in precipitation data for the Southern Hemisphere. Stewart's results (*11*) for Ohakea, New Zealand (40°12′S; 175°23′E), show minor seasonal variation in Sr^{90} content of rains as compared to variations observed at Middle latitudes of the Northern Hemisphere. Unless there are large differences in degree of effect for the two hemispheres, the striking spring peaks in Sr^{90} fallout in north temperate latitudes must be attributed largely to stratospheric debris from preceding Soviet tests. It should also be mentioned that the spring peak in ozone concentration (*30*) is very broad and of low amplitude whereas the Sr^{90} fallout peaks at north temperate latitudes are of greater amplitude and are not confined to the spring season (Figs. 3 and 5).

Since tropospheric injections of Sr^{90} contamination may be reasonably assumed to contribute only a small fraction of total Sr^{90} fallout, the surface distribution (Fig. 6) must be explained in terms of the production schedule, the injection latitudes, and the mixing history of intermediate and large-scale detonations. The 1956 distribution in the Southern Hemisphere is without question due largely to the November 1952 Ivy and the spring 1954 Castle tests, with stratospheric injection at latitude 11° north. The distribution in the Southern Hemisphere exhibits no appreciable variation with latitude. This implies that stratospheric debris from equatorial tests is not selectively mixed downward at middle latitudes to an appreciable degree. If distribution of equatorial test debris is assumed to be similar in the two hemispheres, the north temperate latitude peak in distribution must to a very large extent be the consequence of Soviet tests.

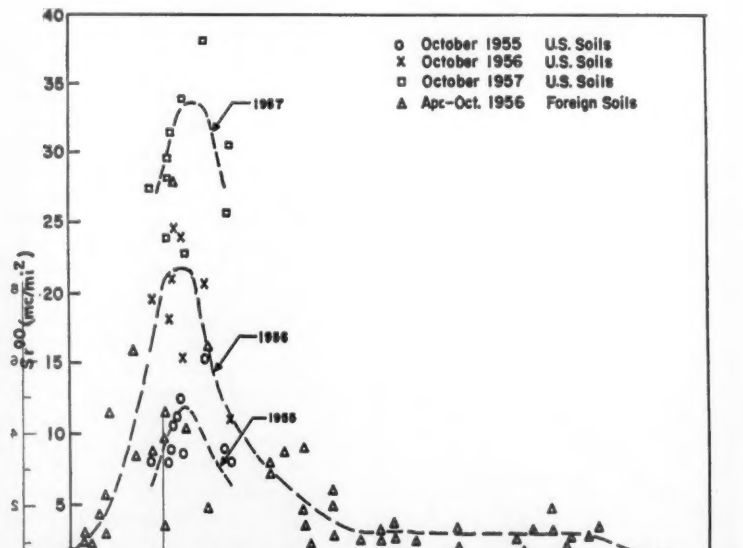

Fig. 6. Surface distribution of Sr^{90} in 1956.

Comparison of the post-Ivy and post-Castle deposition levels in polar snows makes possible an approximate interpretation of the 1956 surface distribution (Fig. 6) in terms of United States and Soviet test contributions. The deposition rate in the Arctic for equatorial tests is estimated to be 1.5 times that for Antarctica. If 1.5 times the Southern Hemisphere is taken as the Northern Hemisphere distribution for equatorial tests and if 5 percent of the Northern Hemisphere levels is assumed to be tropospheric fallout, the balance is attributable to Soviet tests. On the basis of this analysis, Soviet tests are the source of roughly three-fourths of the Sr^{90} fallout in north temperate latitudes.

When the possible histories of circulation and mixing of clouds of stratospheric debris injected at equatorial and middle latitudes are considered, nothing seriously inconsistent with the foregoing analysis is found. The Brewer (*18*) and Dobson (*19*) views of atmospheric circulation indicate poleward flow in the stratosphere and downward mixing at middle and higher latitudes, with more rapid downward mixing in the spring. The influence of the jet stream may further increase the downward mixing of stratospheric air at middle latitudes. If these views of circulation are assumed to be correct, it is indicated that the timing and latitude of Soviet tests fortuitously lead to short storage times and to a quite selective zone of downward mixing and deposition. A markedly different mixing history is to be expected for stratospheric debris injected at equatorial latitudes. The debris may be expected to diffuse rapidly throughout a broad zone of the equatorial stratosphere, under the influence of the strong easterlies in this region. Debris in the equatorial stratosphere will subsequently mix into higher latitudes of both hemispheres; perhaps somewhat more debris will move into the Northern than into the Southern Hemisphere from United States tests at 11° north latitude.

A long stratospheric residence time for debris in the equatorial stratosphere would mean a slow rate of exchange from this region into higher latitudes. The rate of poleward mixing in the stratosphere may vary appreciably with altitude and season. H. Wexler (*31*) has pointed out that the average meridional geostrophic wind speeds, (at 10° to 70°N) at 19 kilometers in altitude, are at a minimum in August and at a maximum in March and April; this suggests more rapid northward migration of debris for spring tests. The observed initial arrival times for equatorial test debris at mid-latitude ground levels [about 3 months (*21*)] and later at high latitudes [9 months (Table 3)] are qualitatively consistent with observations of the rate of northward spread of the Krakatoa volcanic dust cloud (*31*) and of the vertical mixing of ozone (*30*). In his discussion of the Krakatoa cloud spread, Wexler (*31*) has pointed out that the average meridional wind speeds, at an altitude of 19 kilometers, are a maximum at low latitudes, decrease to a minimum at middle latitudes, and increase somewhat at higher latitudes. The ozone data for middle latitudes show that the peak in surface air concentration postdates the period of maximum total ozone content by about 2 months, indicating the approximate time required for vertical mixing from the 20-kilometer ozone layer to ground levels. Thus, the 3 months required for Castle debris to arrive at middle latitudes must correspond to about 1 month required for northward mixing and 2 months required for vertical mixing. The subsequent slow increase in Sr^{90} concentration in middle latitudes and the late arrival of Sr^{90} fallout in polar areas reflect a slow exchange out of the equatorial stratosphere northward through the region of low meridional winds. Clouds of nuclear debris from Soviet tests at 52° north latitude, injected in the region and usually in the season of lowest meridional wind speeds, probably undergo little diffusion before mixing downward, perhaps quantitatively, into the lower atmosphere.

It appears that debris from equatorial detonations of high-yield devices is reasonably well mixed in the equatorial stratosphere and that subsequent circulation does not effect appreciable latitudinal or seasonal variation in Sr^{90} fallout. Middle-latitude tests of intermediate and high-yield weapons must account to a large extent for the observed seasonal and latitudinal variation in Sr^{90} deposition in the Northern Hemisphere. The differences in mixing history and ultimate distribution for stratospheric debris injected at low and middle latitudes are important consequences of stratospheric meteorology. Seasonal effects undoubtedly influence the circulation and deposition of fallout but may be assigned a secondary role in the explanation of major variations in fallout rate.

On the basis of the foregoing consideration of the Sr^{90} fallout evidence, the following summary remarks and tentative conclusions may be stated.

Uncertainties about the amounts of Sr^{90} that have been injected into the stratosphere, coupled with lack of adequate information about the origin and distribution of the Sr^{90} already deposited over the earth's surface, make it difficult to assess stratospheric holdup times and limit the accuracy of fallout distribution predictions.

Precipitation washout is the predominant mechanism of Sr^{90} fallout. Gravitational fall of dry particulate material appears to contribute a negligible fraction of the total Sr^{90} fallout.

Within a limited geographical zone of uniform circulation and of characteristic rainfall type, the cumulative S^{90} fallout will be approximately proportional to total rainfall. In the Northern Hemisphere there is a marked variation in Sr^{90} fallout, dependent on the location of the area with respect to the zone of entry for stratospheric debris from Soviet tests. The seasonal distribution of rains further modifies the Sr^{90} distribution. In the Southern Hemisphere the annual rainfall appears to be the major factor in Sr^{90} distribution.

Stratospheric debris injected by high-yield atomic tests at equatorial latitudes appears to undergo diffusion throughout a broad region of the equatorial stratosphere and subsequently mixes poleward, roughly equivalent amounts being contributed to each hemisphere. A relatively long stratospheric storage time of perhaps 5 to 10 years and an approximately uniform hemispheric distribution, reduced toward the pole, are indicated in this case.

Clouds of stratospheric debris from middle-latitude nuclear detonations apparently reach lower stratospheric levels after only limited diffusion and release substantially all of their contamination into a zone of restricted latitude during the first 6 months or so. The spring peaks in Sr^{90} deposition rate and the band of heavy fallout at north temperate latitudes are attributable principally to high-yield Soviet tests.

The direct injection of contamination into the troposphere is apparently limited to detonations not exceeding 100 to 200 kilotons. Strontium-90 activity from this source is quite widely dispersed and has amounted to only a few percent of total fallout to date.

The total Sr^{90} fallout at north temperate latitudes from high-yield tests at these latitudes is higher by a substantial factor than that from equivalent equatorial tests. Perhaps even more important, the short stratospheric holdup time for middle-latitude tests allows for substantial deposition before decay of the shorter-lived fission products which con-

tribute to external gamma radiation and its possible genetic effects. It is clear that estimates of future contamination from high-yield detonations at north temperate latitudes must be revised upward from estimates based on 5- to 10-year periods of stratospheric storage (32).

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32. I am indebted to Dr. W. F. Libby, Dr. L. T. Alexander, Dr. R. A. Craig, Dr. C. E. Junge, and Mr. I. H. Blifford, Jr., for numerous helpful discussions and suggestions. I wish to thank Dr. Henri Bader of the Snow, Ice and Permafrost Research Establishment (Wilmette, Illinois), Mr. Paul Humphrey of the U.S. Weather Bureau, and members of the U.S. International Geophysical Year organization for their generous assistance in obtaining the snow samples from Antarctica and Greenland.

Recent Saprolite

Thick saprolite has formed in northern New Jersey since the last Pleistocene glacial stage.

James P. Minard

Thick saprolite is present in glaciated terrane of northern New Jersey under field conditions suggesting formation within a comparatively short time interval. The saprolite has developed on a low spur lying along the east side of a glaciated valley, normal to the direction of former ice movement. It is quite probable that the saprolite has weathered from consolidated rock since the latest (Wisconsin) glacial period.

A gneissic saprolite, the maximum age of which is possibly determinable, is present in northern New Jersey, 5 miles north of the southern static limit of Wisconsin glaciation. The saprolite is exposed in a pit along the east side of route 206, east of Cranberry Lake, Sussex County. The saprolite is along the west side and near the base of a north-trending bedrock ridge; it forms a benchlike spur, the upper surface of which is 50 to 60 feet above the swampy terrain west of the highway.

The rock from which the saprolite formed is shown on the geologic map as Pochuck gneiss of Precambrian age (Fig. 1). The rock is an amphibolite gneiss containing much hornblende, considerable oligoclase and diopside, and some quartz, magnetite, and microperthite.

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Outcrop Description

A thickness of nearly 15 feet of saprolite is exposed in a pit approximately 200 feet wide and 300 feet long. The saprolite is easily excavated and crumbles readily, under hand pressure, into a sticky, clayey, gritty mass. At least 12 feet of saprolite underlies the pit bottom, giving a minimal thickness of 25 feet. Because of the gentle slope and absence of bedrock downhill from the pit, the total thickness of saprolite may be as much as 40 feet. Overlying the saprolite in the pit is several feet of well-weathered glacial till. Except for a shallow A horizon of the soil profile, the till and the upper few inches of the saprolite apparently comprise the 2- to 3-foot-thick B horizon of the soil profile, and the rest of the saprolite forms the deep C horizon. By comparison, saprolite formed from unglaciated gneiss 3 miles south of Chester (see Fig. 2) is nearly 60 feet thick and has a substantial A horizon and a thick (5 to 6 feet) B horizon.

Remarkably continuous light and dark gneissic layering can be seen in the exposure (see Figs. 3–5). These layers are one-eighth to 1 inch thick and are many feet long. The layering dips approximately 15° south, except in the west

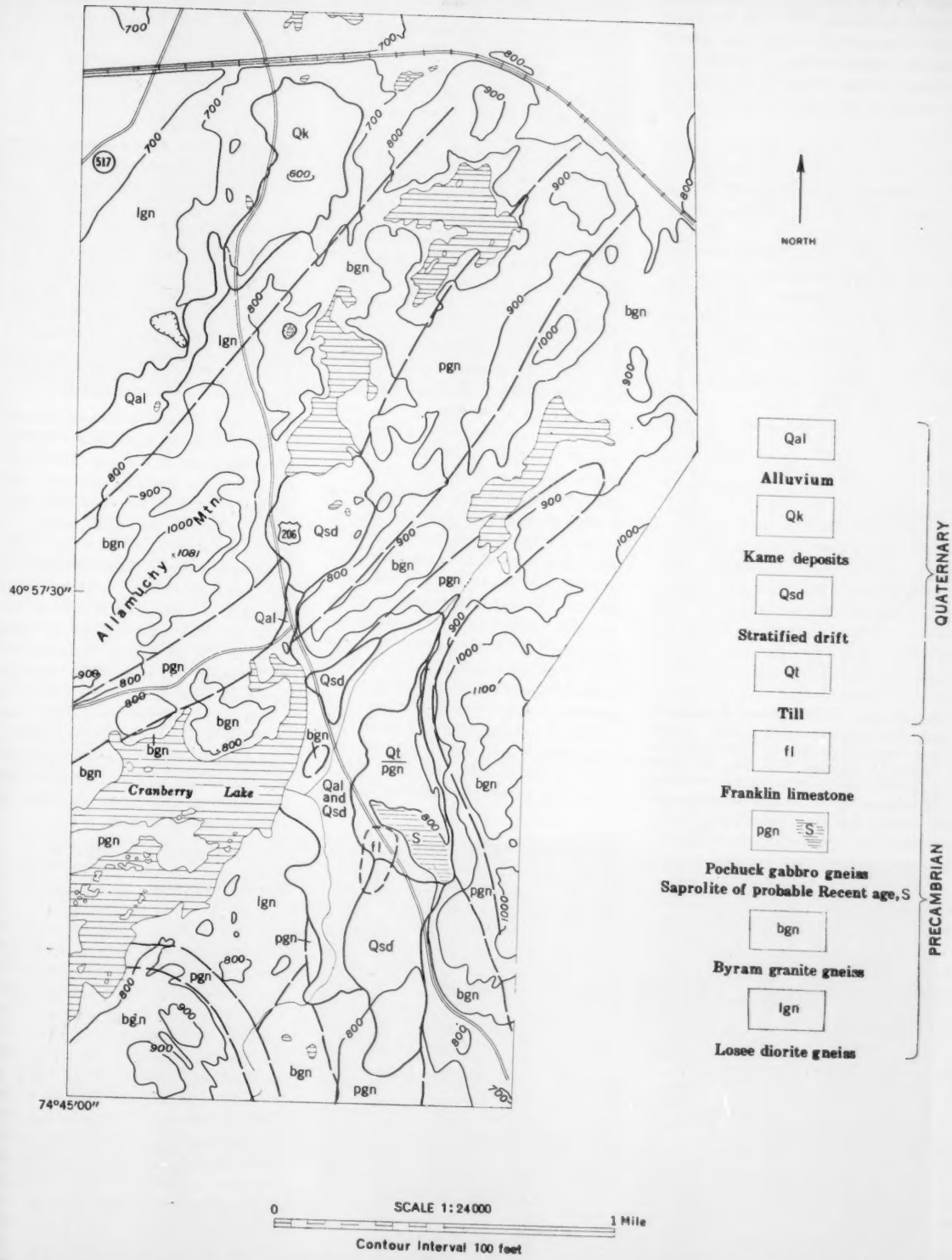

Fig. 1. Generalized geologic map of saprolite area. [W. S. Bayley, R. D. Salisbury, H. B. Kummel, "Geologic atlas of the United States, Raritan folio," *U.S. Geol. Survey Publ.* (Government Printing Office, Washington, D.C., 1914)].

part of the pit, where, near the contact with the overlying glacial till, it becomes nearly horizontal. This may be the result of soil creep down the slope. Except for this slight bending, the gneissic layering is neither deformed nor distorted at or below the contact with the glacial till.

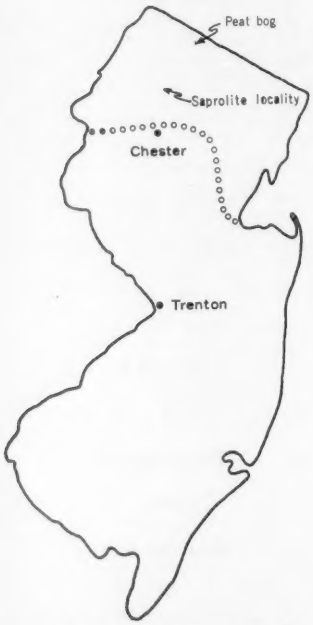

Fig. 2. Map of New Jersey, showing the saprolite location and the postglacial peat bog from which samples were taken for carbon-14 analysis. The line of circles represents the terminal moraine of the Wisconsin stage of continental glaciation.

Evidence for Dating

The significance of this exposure of saprolite lies in its presence several miles north of the terminal moraine of the Wisconsin stage of continental glaciation. Bare, glacier-scoured bedrock hills and ridges typify the area. Almost all unconsolidated material in the area is glacial till or drift. Only small patches of residual soil are present, and these are extremely thin.

Here, beneath several feet of glacial till, is at least 25 feet of well-weathered (*in situ*), easily excavated rock material that forms an obstructing spur projecting into a glaciated valley that trends essentially parallel with the direction of former ice movement. It seems improbable that the rotten rock could have survived the glacial erosion had it been, at that time, in its present physical state, or that the gneissic layering would be without distortion or deformation at the sharp contact with the glacial till. It may be postulated that the saprolite was formed prior to glaciation and escaped removal because it was frozen. However, some indication of its frozen state, such as congeliturbate structure, would be expected. The silty, clayey texture of the saprolite would have made it highly susceptible to freeze-thaw processes. If, on the contrary, it is assumed that the rock from which the saprolite developed was essentially unweathered resistant rock during the glacial period, it must have undergone nearly complete weathering to its present crumbly state since glacial time. This period of weathering may be as much as 18,000 to 20,000 years, if the terminal moraine a few miles to the south correlates with the climax of the Wisconsin stage of continental glaciation, or as little as 12,000 to 13,000 years, if the moraine correlates with the latest pulse of the Wisconsin glaciation (*1*).

A carbon-14 date was established (*2*) from peat obtained in northeastern Sussex County. The sample was submitted by Meredith E. Johnson (*3*) and was taken from a bog in which a nearly complete mastodon skeleton was found buried under 9 feet of peat. The peat and mastodon remains rested on glacial till. The depth of the peat increased to approximately 20 feet just west of the mastodon remains. The location of the bog, shown in Fig. 2, is three-fourths of a mile west of Highland Lake. The age of the peat was determined to be 10,890 ± 200 years.

A clearly defined recessional moraine is present east-west across Sussex County, 10 miles south of the bog. The recessional moraine probably correlates with the latest pulse of the Wisconsin stage and is older than the bog by as much as several thousand years (time for a sufficient static stage to allow formation of the prominent moraine, withdrawal for 10 miles, and formation of 5 to 10 feet of peat). The saprolite lies 10 miles south of the recessional moraine, and the terminal moraine which probably correlates with the climax of the Wisconsin stage (18,000 to 20,000 years ago?), is 5 miles south of the saprolite. The saprolite dates somewhere between the 14,000- to 15,000-year-old pulse and the 18,000- to 20,000-year-old climax of the Wisconsin glaciation.

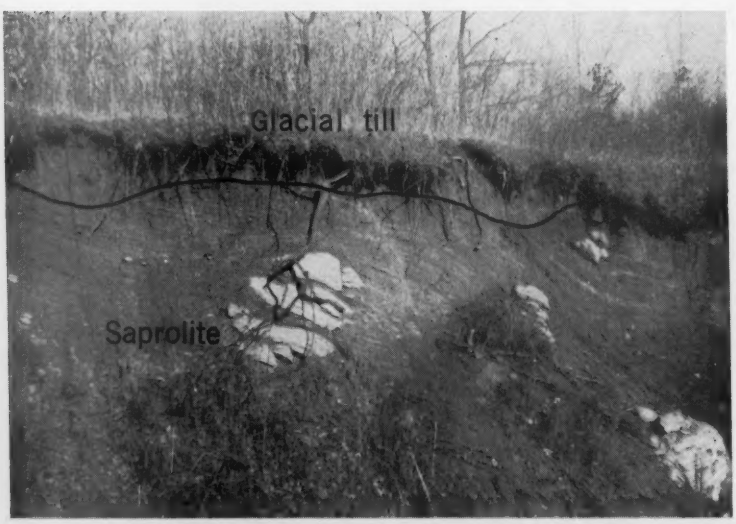

Fig. 3. View of the north wall of the pit, showing layering in the saprolite and in the included consolidated rock.

Rapid Weathering

Several favorable conditions or factors may have contributed to the rapid, deep weathering of the Pochuck gabbro gneiss. MacClintock (*4*) made a study of weathered gneiss pebbles and cobbles in the Jerseyan drift (partly correlative with the Kansan stage and recognized only south of the Wisconsin drift). Many of the gneiss pebbles and cobbles in the Jerseyan drift can be crumbled easily by hand pressure (I have observed similar cobbles in the Wisconsin drift at several localities in Sussex County). MacClintock attributed the advanced weathering to several conditions and factors other than the chemical nature of the rock. They are (i) a humid climate and considerable precipitation; (ii) a location well above the permanent ground-water

Fig. 4. Close-up of the saprolite and the consolidated rock. The gneissic layering is continuous from the saprolite through the consolidated rock.

table; (iii) a certain amount of clayey or silty fractions in the drift. The first provided a copious supply of water; the second assured an exchange of percolating water, so that when any unit of water had dissolved rock constituents to its capacity, more fresh water could take its place; and the third retarded percolation somewhat, so that nearly maximum leaching was accomplished by any unit of water. MacClintock found that the highest percentage of completely weathered gneissic pebbles and cobbles was in the silty and clayey layers of the drift.

These conditions existed in the saprolite locality. The saprolite spur has received a considerable amount of precipitation; it is well above the ground-water table; and, because of a tight joint system in the initial phases of weathering and the presence of residual and illuviated clayey constituents in later phases, ground-water percolation has been retarded. Furthermore, because the saprolite spur is near the base of a long slope, it receives a considerable amount of water for some time after each precipitation.

Fig. 5. Close-up of consolidated rock from the saprolite. The layering is uniform and continuous.

Supporting evidence for rapid, deep weathering is reported in Hunt and Sokoloff's paper (*5*). "Deep soils representing the residual effect of rock weathering are commonly attributed to considerable absolute age, but the age is probably one of the least important of all the factors that must have controlled the development of so deep and mature a profile as characterizes this soil. . . . It is even possible that the paleosol (approximately 20+ feet) actually required no longer time to develop than has been required by the shallow Wisconsin (approximately 2 feet) and younger soils in this region. Given favorable moisture and temperature conditions and appropriate animal and vegetable life to accelerate biochemical activity, it is not at all difficult to visualize rather rapid rock decomposition and deep soil development."

Conclusion

The presence of a relatively thick occurrence of soft, crumbly gneissic saprolite in a predominantly glacier-scoured bedrock terrane offers a possible means of determining the rate of weathering of the parent rock. Analysis of the supporting evidence indicates that the rock from which the saprolite formed must have been essentially unweathered when overridden by the ice. The supporting evidence includes (i) the position of the saprolite on a spur projecting into a glaciated valley and subject to severe glacial scouring; (ii) the lack of distortion or deformation of the gneissic layering at the contact with the overlying glacial till; and (iii) the absence of any comparable residual soil, with similar boundary conditions, elsewhere in the glacier-scoured bedrock terrane of this vicinity.

On the basis of this evidence, I believe that the saprolite formed as a result of weathering of the Pochuck gabbro gneiss of Precambrian age since the last withdrawal of the ice, somewhere between 14,000 to 15,000 and 18,000 to 20,000 years ago (*6*).

References and Notes

1. R. F. Flint and M. Rubin, *Science* 121, 649 (1955).
2. Sample No. L-231 in W. S. Broecker and J. L. Kulp, *ibid.* 126, 1329 (1957).
3. Dr. Johnson is state geologist of New Jersey.
4. P. MacClintock, *Bull. Geol. Soc. Am.* 51, 103 (1951).
5. C. B. Hunt and V. P. Sokoloff, "Pre-Wisconsin soil in the Rocky Mountain region, a progress report," *U.S. Geol. Survey Profess. Paper No. 22* (1949), pp. 117–118.
6. Publication of this article was authorized by the director of the U.S. Geological Survey.

News of Science

Radiation Hazards Pose Problem of How Government Can Best Be Organized to Protect the Public

During the past few weeks Congressmen, labor leaders, state officials, scientists, and citizens groups have voiced renewed concern about the dangers from weapon testing, the faster rate of fallout, the rising radioactivity in milk and other foods, and the growing problems of industrial radiation and atomic waste disposal. There has been particular concern as to how the Government can best be organized to monitor fallout and establish radiological health standards.

A movement is developing within the Administration and within the Congress to place primary responsibility for the nation's protection from radiation hazards in a single agency of the Federal Government. So far the Atomic Energy Commission has been chiefly responsible for work in this area. However, it is now being suggested in many quarters that the Public Health Service assume control, for there is a growing feeling that "it is unwise to continue the assignment of authority over the public health aspects of atomic energy to the same agency that has a prime interest in the promotional aspects in the field." This statement is from a recent report by the National Advisory Committee on Radiation Protection, a committee that was set up by the Public Health Service; however, none of the 12 committee members is from that agency, and only two are federal employees. The committee chairman is Russell H. Morgan, professor of radiology at Johns Hopkins Medical School.

The National Advisory Committee's report, which appeared in the 17 April issue of *Science*, was the culmination of a wave of criticism of the AEC's administration of the radiation control program. In response, commission chairman John A. McCone made the following statement to the Joint Committee on Atomic Energy at hearings on 29 March: "The importance of the fallout and sampling program is thoroughly recognized by the AEC and it is our intent to continue an active program. However, we have no desire to pre-empt this area of activity and if the Congress and the Executive Department wish to assign part of this activity to other Federal agencies we will cooperate with them to the fullest."

Atomic Energy Commission Program

In this fiscal year, the AEC will spend $19 million in research associated with radiation standards and protection. In addition, $2.6 million is being spent for sampling and analysis for national and world-wide fallout studies and $450,000, for fellowships for training in health physics, industrial hygiene, and so forth. It is expected that in 1960 the figures for radiation standards and protection will be increased to $20 million; these funds will be provided out of a $50-million operations budget for biomedical research. The AEC, since it was established in 1946, has used approximately $125 million for biomedical investigations on radiation.

Some 800 scientists are engaged in this work, backed by an equal number of laboratory technicians. Research is carried out at the Brookhaven, Argonne, and Oak Ridge laboratories, at the University of California's Lawrence and Los Alamos laboratories, and through contract with 204 universities and 19 corporations.

Arrangements for the exchange of information on sampling and of other fallout data exist between the AEC and a number of other federal offices, such as the Weather Bureau, the Department of Agriculture, the Public Health Service, and the Food and Drug Administration. Active sampling programs are being conducted in a number of countries with which the AEC exchanges information. These countries are widely dispersed over the world and include, for example, Japan, New Zealand, Norway, England, and Brazil. In addition to conducting a world-wide atmospheric sampling program, the commission has 64 soil-sampling stations in foreign countries and 17 in the United States.

Project Sunshine

No comprehensive up-to-date account of all the AEC's radiation control work is available, nor is it possible to obtain a clear-cut description of Project Sunshine, the commission's chief program dealing with the large-scale distribution of radioactivity. Sunshine was set up secretly in 1953, at the suggestion of AEC Commissioner Willard Libby, to study the fallout that could be expected in an atomic war. With the 1954 hydrogen bomb tests in the Pacific, the emphasis shifted to a study of the fallout from weapon tests, particularly of strontium-90.

The work is under the supervision of the Division of Biology and Medicine, which is headed by Charles A. Dunham. Forest Western is his assistant director for radiation protection. When asked recently to outline the scope of Project Sunshine, Western answered: "Unfortunately I can't answer, for the project has never been defined." He then went on to explain that when Sunshine was established, the division already had an extensive program of research on the biological aspects of radiation—some of it especially concerned with the hazard question, some not. This work continues today. Western pointed out that this separate research program has resulted in a complicated overlapping of activities that has sometimes led to confusion in connection with Sunshine.

Recently there has been criticism of the AEC because no one person is solely responsible for Project Sunshine. In answer to a question about this, Western said that the commission had been unable to recruit any of the men it had selected.

Atmospheric Radioactivity Studies

Joshua Z. Holland, meteorologist and a biology division member who devotes all his time to fallout problems, recently described one major aspect of the AEC's fallout work with commendable simplicity and conciseness. He delivered a paper before the American Meteorological Society that is a synthesis of the commission's biologically motivated studies of atmospheric radioactivity. This paper is now being prepared for release as a regular AEC information report. It will be accompanied by a number of helpful charts and tables, including Table 1, shown here, which outlines the fallout sampling networks that provide the bulk of the AEC-sponsored measurements of radioactivity in the atmosphere and in precipitation.

Sampling Methods

In Table 1, where the AEC is listed alone, this indicates that the entire project—both the collection and the analysis of samples—is under the supervision of the Health and Safety Laboratory (New York Operations Office); where the AEC is listed jointly with another agency, that agency is responsible for the collection and the Health and Safety Laboratory is responsible for the analysis. All of the data from the various programs

Table 1. Data from Atomic Energy Commission fallout monitoring networks.

Type of sample	Operating agency	Number of stations	Frequency of sampling	Geographical extent	Analysis
Gummed film	AEC	197	Daily	Worldwide	Total beta radiation
Precipitation in pots and funnels	AEC	57	Monthly	Worldwide	Sr^{90}, Sr^{89}, W^{185}, total beta radiation
Precipitation in washtubs	AEC	4	With each rain	U.S. and New Zealand	Sr^{90}, Sr^{89}, (U.S.), Cs^{137} (N.Z.), Ba^{140}, W^{185}, total beta radiation
Other	AFCRC*	6	Biweekly	76°N to 41°S	Sr^{90}, Ba^{140}, W^{185}, Pb^{210}, H^3
Other	PHS†	44	Daily	U.S.	Total beta radiation
Other	USGS‡	3	Biweekly	N. America	H^3
Soil	USDA§-AEC	87	Every 2 years	Worldwide	Sr^{90}
Soil	AEC	17	Every year	U.S.	Sr^{90}
Surface air	NRL‖	28	Daily	Worldwide	Daily: total beta radiation; monthly: Sr^{90}, Sr^{89}, Y^{91}, Cs^{137}, Ce^{141}, Ce^{144}, Pb^{210}, W^{185}
Surface air	PHS†	44	Daily	U.S.	Total beta radiation
Upper air	USAF¶-AEC	4	Monthly	45°N to 23°S	Sr^{90}, Sr^{89}, Zr^{95}, Cs^{137}, Ba^{140}, Ce^{144}, W^{185}, Rh^{102}, total beta radiation

* Air Force Cambridge Research Center (with partial AEC support); † U.S. Public Health Service; ‡ U.S. Geological Survey (with partial AEC support); § U.S. Department of Agriculture; ‖ Naval Research Laboratory (with partial AEC support); ¶ U.S. Air Force.

noted in the table are eventually sent to the Weather Bureau, which conducts comprehensive studies and makes worldwide graphs and so forth. Lester Machta heads this work.

The table indicates several sampling methods. The gummed film collector mentioned consists of a square foot of cellulose acetate film coated with rubber-base cement. Two of these are exposed at each station per day. At the end of the collection period, the films are folded and mailed in a preaddressed envelope to the Health and Safety Laboratory. The people who do this collecting are volunteers; the AEC does not have teams in the field for this work.

It has been found that fallout collectors that retain precipitation, while not providing such convenient samples for counting, collect more radioactivity per unit area than does the gummed film. In fact, it appears that most of the strontium-90 fallout is brought down by rain and is not retained by gummed film. Therefore, 1-foot stainless steel pots have been used as collectors. Samples are transferred to polyethylene bottles and mailed in. The pots are now being replaced by a new collector consisting of a funnel and simple ion-exchange column that will facilitate and standardize the sample-handling procedure.

Air filter samplers are also widely used to collect airborne dust. These are an essential part of local industrial radiation protection programs.

Soil sampling is the best measure of the total strontium-90 which has fallen per unit area of earth's surface. However, analysis of bulky samples is far more difficult than analysis of the more concentrated types of samples. Lyle Alexander of the Department of Agriculture's Bureau of Plant Industry is in charge of the chief soil survey, which is international in scope.

Environmental Radioactivity Studies

Hal L. Hollister, a physicist, is the other person in the Division of Biology and Medicine who works full time on fallout; his province is environmental contamination. The commission has many projects in this area. For example, a pasture survey for the analysis of plants, soil, whole animals, bone, and milk is being conducted by the Health and Safety Laboratory in cooperation with the Department of Agriculture. Ocean sampling programs are being carried out at Stanford University, the University of Washington, the Woods Hole Oceanographic Institution, the University of Miami, the University of California's Scripps Institution for Oceanography, and the Lamont Geological Laboratory of Columbia University. The last also has a program to study strontium-90 in human bone. The bones of cadavers are contributed by cooperating groups all over the world.

At the Los Alamos Scientific Laboratory there is a program to determine whole-body concentrations of cesium-137; everyone who visits the laboratory is checked. In addition, the laboratory conducts a milk survey under which powdered milk is collected at many points in the United States and Canada. And finally, there are various food analysis projects, although an AEC spokesman commented that these are "not very systematic."

Public Health Service

Since the discovery of the x-ray 50 years ago, the Public Health Service, as the principal federal health agency, has been concerned with radiation hazards and has engaged in the compilation and distribution of data on radiation and the investigation of accidents and other activities. In the 1930's, for example, the PHS participated in the investigation of radium poisoning in workers who painted dials in watch factories. During World War II, staff members worked with personnel at the Manhattan District in establishing standards for radiation tolerance.

In 1945, the Division of Tuberculosis set up and published radiation standards for photofluorographic technicians. Both the National Institutes of Health and the Bureau of State Services initiated training programs in 1948 to increase the technical competence of PHS personnel, and in the same year a Radiological Health Branch was set up with a budget of $17,638.

By 1955, the program had expanded to include 39 positions and a budget of $260,000. During the previous 7 years, the Service had undertaken studies of stream characteristics of the Columbia River Basin near the Hanford atomic energy works and a study of hazards to uranium miners on the Colorado plateau; it had also started radiological training activities at the Robert A. Taft Sanitary Engineering Center in Cincinnati. In 1953, the Service began collaborating with the AEC in the off-site monitoring of weapon tests.

In 1956, the Surgeon General established a series of staff studies to determine more precisely the nature of the radiological public-health problem and the role of the PHS. The fundamental problems, it was agreed, were those of determining more precisely the tolerance levels of radiation exposure, developing means of protecting human beings from unnecessary exposure, and disseminating information to members of the public health profession and the public.

On 5 February 1958 Arthur S. Flemming, Secretary of Health, Education, and Welfare, approved the establishment of a Division of Radiological Health in

the Bureau of State Services. In February of this year, the Surgeon General also established the National Advisory Committee on Radiation, mentioned earlier, to advise him and the newly established division.

Radiological Health Budget

The Division of Radiological Health, with Francis J. Weber as chief, began operating last July. For fiscal 1958, the budget was $390,000; for 1959, it is $608,000. The staff has been expanded to 76 persons.

A principal activity of the division is the training of personnel in the technical aspects of radiation in relation to health. In 1958 the Service offered short topical courses to 351 personnel from states and communities. Nine of these courses are being conducted this year.

To date, 43 stations have been set up for the measurement of radioactivity in the air, 45 stations for testing water, and 10 for sampling milk. Samples are analyzed once a month, and the methods used have been sent to state health departments.

On 16 March Flemming held a news conference to discuss radiation problems. As background for the Public Health Service's present interest in the field, he reminded his audience that it was the PHS that several years ago advocated the abolition of x-ray machines for fitting shoes and that last year proposed the substitution of skin tests for mass x-ray surveys as the first step in detecting tuberculosis.

He then went on to describe Department of Health, Education, and Welfare plans for 1960 for the Public Health Service. The department's budget for 1960 calls for slightly more than a doubling of the capabilities of the PHS in the field of radiation. The request is for an appropriation of $1,439,100, an increase of $805,000 and the largest single increase within the Service. This is in addition to the some $2 million being devoted to the study of radiation by the National Institutes of Health through grants-in-aid and in its own laboratories. The expanded PHS effort would be made in three categories—research, technical assistance to states and communities, and training of personnel. The research proposed would include studies of two types of population groups—individuals exposed to radiation in industry and individuals exposed in the course of medical diagnosis and therapy. In addition, the research would seek to simplify and standardize tests used to measure radiation levels.

On 3 April, just a few days after the release of the report of the National Advisory Committee on Radiation, the White House announced that the President had asked that a special study of the administration of the radiation control program be conducted by the Bureau of the Budget. Among the problems the study will consider is whether the principal responsibility for protecting the public against the effects of radiation should remain with the Atomic Energy Commission or be transferred to the Public Health Service. Participants in the survey include the leading officials of the two agencies chiefly concerned—John A. McCone of AEC and Arthur S. Flemming of HEW. A report of the Budget Bureau's investigation is expected soon, for on 5 May the Congress' Joint Committee on Atomic Energy will open hearings on the issue.

Soviet Pay Scale Revision

Scientists in the U.S.S.R. were told recently that the mere possession of a doctor's degree was no longer a guarantee of a lifetime of luxury in the nation's top salary brackets. Drastic changes in the system of wages and payments to scientists, providing for payment based on quality of work rather than on academic degrees, are being drafted.

The measure promises to close the large gap between the salaries of academicians and others who teach and do research, on the one hand, and scientists and engineers who are directly connected with production on the other. A secondary result, it is hoped, will be elimination of the log jam of applications for advanced degrees that has kept scores of scientists bogged down in the process of training candidates for degrees. The proposed wage changes were announced briefly in *Literaturnava Gazeta* by the deputy chairman of the State Committee on Labor and Wages.

Academic Freedom Committee Attacks Defense Education Act

The Academic Freedom Committee of the American Civil Liberties Union last month criticized the 1958 National Defense Education Act as threatening the traditional freedom of colleges and universities with control by the Federal Government. The committee's statement was signed by its chairman, Louis M. Hacker, professor of economics at Columbia University and former dean of its School of General Studies, and by ACLU executive director Patrick Murphy Malin. The statement pointed out that "Civil liberties are chiefly endangered by the law, not in its most-publicized loyalty-oath provisions (to which we are opposed, as we always have been to such provisions), but in the broad wording of provisions which confer power on the Commissioner."

As examples of undue power accorded to the commissioner, the statement cited sections of the act authorizing him to: (i) determine which accrediting agencies or associations are reliable authority as to the quality of training offered at the various institutions of higher education; (ii) award fellowships only upon his finding that the program will substantially increase facilities for training teachers; and (iii) determine whether or not each fellow is "maintaining satisfactory proficiency."

The Hacker-Malin statement described the widely criticized loyalty oath required by the act as "one of those superficially attractive catch-all attempts, popular early in this decade but now increasingly outlawed or discarded," which actually "have a most harmful effect, especially in education, where freedom of thought and association should be most protected and encouraged."

Listing of Psychologists

In the forthcoming (tenth) edition of *American Men of Science* there will be four volumes covering individuals of note in the biological and physical sciences and a fifth covering those in the social and behavioral sciences; hence, the problem has arisen as to where psychologists should properly be listed. For example, the biography of a psychologist working in the field of biology might appropriately be included in the volumes on the biological sciences even though the subject of the biography is a social or educational psychologist. In such a case, a brief cross reference to the biography in question would be included in the volume on the social and behavioral sciences.

It has been suggested by the American Psychological Association that psychologists who have a preference should advise the editor as to the category—biological and physical sciences or social and behavioral sciences—in which they wish their full biographical listing to appear. Letters on this subject should be sent immediately to *American Men of Science*, Arizona State University, 820 College Avenue, Tempe, Arizona. All information for the A-E volume for the biological and physical sciences should be in the hands of the editor before 1 June.

Coal-Tar Color Ban

The Food and Drug Administration announced recently that it was preparing to order the removal from the market of 17 coal-tar colors, which are used principally in lipstick. It will issue an order to this effect when the legal re-

quirements under the Food and Drug Act have been completed. Under the law, interested persons will be allowed 30 days in which to make written comments. Any such observations "will be taken into account in the drafting of the order," the announcement said. This action followed 2 years of tests that proved seven of the banned colors had caused "definite injury" when ingested by animals. Ten other colors were so similar in chemical composition to those tested that they were also ruled off the cosmetic market.

Nuclear Medicine at Chicago

The University of Chicago is establishing a section of nuclear medicine in the department of medicine of the Division of the Biological Sciences to serve as a focal point for those members of the unversity with special interest and competence in the broader aspects of nuclear energy relating to public health. To help support the section over a 10-year period, the Rockefeller Foundation has appropriated $500,000.

In cooperation with other divisions of the university, the section of nuclear medicine will examine the legal, psychological, and social implications with respect to community development and industry of various problems arising from the use of nuclear energy. Attention will be given such general areas of concern as the increase in natural background radiation resulting from the use of nuclear devices and the probable consequences, genetic and physiologic, of increased exposure of man and domestic animals to ionizing radiations.

Moon Relay Station

Using the moon as a passive relay station, the U.S. Navy will establish a new radio communications link between Washington and Pearl Harbor, the country's major military command center in the Pacific. The new system, known as the Communications Moon Relay Project, is the outgrowth of 9 years of work by the Naval Research Laboratory.

The new system will transmit radio signals from large saucer-shaped antennas 84 feet in diameter. These signals will bounce off the surface of the moon and will be picked up by parabolic antennas at the receiving end. The signals will make the trip in two and a half seconds. The surface distance between Washington and Pearl Harbor is 4519 miles. By way of the moon, the distance is approximately 460,000 miles.

A number of major advantages are expected to result from the new system. Reliability in transmission is perhaps the major one. Unlike conventional radio channels, the moon-relay system will not be impaired by noise interference and by blackouts caused by disturbances in the ionosphere. Another advantage is that the system will be virtually invulnerable to jamming. One method of jamming the moon circuit would require the location of a jamming station within a few miles of either the receiving or the transmitting station. A second jamming technique, that of sending signals of the same frequency to the moon, could be overcome by rapid variation in the frequency of the signals sent by this country. In addition to these advantages, the new system opens up a whole new spectrum of frequencies in the already overcrowded radio channels for long-range communication.

The transmitting and receiving stations are now under construction, and pilot operation is expected to begin within the coming year, according to Navy officials.

News Briefs

The European Atomic Energy Community (Euratom) and the U.S. Atomic Energy Commission have announced that private and government enterprises in the six countries comprising Euratom have been invited to submit proposals to build and operate nuclear power plants under the joint United States–Euratom nuclear power program. The objective of the program is to install within the community in the next 4 to 6 years approximately 1 million kilowatts of electrical generating capacity. Those who intend to submit proposals are requested to give notice to the Euratom Commission *by 28 May*. The deadline for submission of proposals is *1 September*, and the date for selection of projects by Euratom and the U.S. AEC is 31 December.

* * *

The state of Victoria in Australia has recently established the state's second university, Monash University, at Clayton, in the metropolitan area of Melbourne. An interim council for planning is now advertising certain key positions, including those of vice-chancellor and librarian. There are also openings for professors of engineering, chemistry, physics, and biology. For information write to Mr. T. B. Paltridge, Australian Scientific Liaison Office, 1907 K St., NW, Washington 6, D.C.

* * *

The N.S. (nuclear ship) *Savannah*, the first nuclear-powered merchant vessel, will be launched on 21 July at the New York Shipbuilding Corporation shipyard, Camden, N.J. President Eisenhower, in implementing the legislation authorizing construction of the ship, in October 1956, directed the Atomic Energy Commission and the Department of Commerce to proceed as rapidly as possible with the design and construction, saying: "This new vessel will be a floating laboratory, providing indispensable information for the further application of atomic energy in the field of ocean transportation."

* * *

A new column entitled "Spectroscopic Tricks" has been started in *Applied Spectroscopy*. Brief contributions (not exceeding 500 words) that describe new or modified techniques and instrumentation in the field of spectroscopy may be sent to the editor, Leopold May, Psychiatric Institute, University of Maryland, Baltimore 1, Md.

* * *

The Society of Biological Psychiatry is a new affiliate of the AAAS. The society holds independent meetings and at times it also meets with other organizations, such as the combined meeting to be held in Atlantic City, N.J., 13–14 June, with the American Electroencephalographic Association. The society offers an annual prize for the best original research paper, and it has a research committee which sponsors research everywhere, for the organization is both national and international in scope. Joseph Wortis is president, and the secretary-treasurer is George N. Thompson, 2010 Wilshire Blvd., Los Angeles 57, Calif.

* * *

An 18-page printed booklet on *Nuclear Science Fellowships* has been published by the International Atomic Energy Agency in Vienna to inform governments of opportunities and procedures for obtaining help with the training of specialists for atomic energy programs. The booklet lists training opportunities in 49 specific areas of nuclear physics. Two groups of fellowships are offered—one of some 200 that has been made available to the agency by member governments, and another of a "considerable number" that will be financed out of the agency's own operating fund, which is built up from voluntary contributions.

* * *

Presentation of the first complete high-school chemistry course on motion-picture film, produced by Encyclopaedia Britannica Films, Inc., with the cooperation of the American Chemical Society, was announced at ceremonies in Washington last month. James R. Killian, Jr., Special Assistant to the President for Science and Technology, received a set of the new films on behalf of the Federal Government and was the principal speaker on the program. John C. Bailar, Jr., of the University of Illinois, president of the American Chemical Society,

opened the program by discussing the contribution of the American Chemical Society in helping to produce the films and the ways in which educators can use them most successfully.

* * *

The Engineers Joint Council, 29 W. 39 St., New York 18, N.Y., has announced the release of the 1959 *Engineering Societies Directory*. This is the first revision of this publication since 1956. The directory provides basic information concerning international, national, regional, state, and local engineering groups and lists, for each entry, address, membership, secretary, and organizational publications.

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In England, three stations of the Department of Scientific and Industrial Research—all concerned with the preservation, storage, handling, or protection of foodstuffs—will be transferred to the Agricultural Research Council on 1 July. They are the Ditton Laboratory at Larkfield, Kent; the Low Temperature Research Station at Cambridge; and the Pest Infestation Laboratory at Slough. The agreement between the Council for Scientific and Industrial Research and the Agricultural Research Council was made because the two councils believe that it is in the national interest to bring all government research on food other than fish under one body, in order to make the research more effective.

* * *

Field work has begun on a cooperative oceanographic expedition which will examine some of the sediments of the east shelf of the Gulf of California. Scientists from three institutions—the Scripps Institution of Oceanography, the Universidad nacional autonoma de Mexico, and the U.S. Navy Electronics Laboratory—are now engaged in the first of three trips connected with the study.

Some specific objectives of the project are study of the characteristics of the sediments and morphology of the deposits along a coastal plain-continental shelf; study of "beach ridges"; study of the effects of variations in climate on the characteristics of the sediments and the morphology of the deposits; and study of the transition between subaerial and marine sediments.

* * *

A composite list of 137 research studies on psychopharmacologic drugs which are being conducted under support of grants from the National Institute of Mental Health is now available. These research studies, as classified by the institute's Psychopharmacology Service Center, fall into three main categories: 57 studies directly related to problems of drug development and assessment; 68 studies of the basic mechanisms of the action of psychopharmacological agents; and 12 studies pertaining to method development and data analysis. Single copies of the list of research grants, divided by category and including the name and institution of each investigator and a brief description of his project, are available on request from the National Institute of Mental Health, Bethesda 14, Md.

* * *

The Nuclear Division of the Martin Company has won the 1958 Miniaturization Award for the development of SNAP—111, the 5-pound atomic generator. The award, which annually recognizes advances in the art and science of miniaturization, was presented to the company last month by the president of Miniature Precision Bearings, Inc., sponsor of the program. The generator, developed by Martin under the auspices of the Atomic Energy Commission, is the first device to combine a radioisotopic heat source with a highly efficient thermoelectric conversion system.

* * *

Russian-English and English-Russian dictionaries of terms used in the mathematical sciences are now being prepared by scholars working in this country and in Russia. The combined effort, initiated nearly 3 years ago as one of the results of a mathematical conference held in Moscow, is being supported by the academies of science of both countries. Work on the part of the project being done in this country is expected to be completed by June. Compilers from the University of Michigan are now preparing to get together with their Russian counterparts to review the work done to date. It is expected that the two dictionaries will be published in 1960.

* * *

The International Atomic Energy Agency has approved plans for the setting up of a functional laboratory to be built on a site adjoining the Austrian reactor and atomic laboratories at Seibersdorf, near Vienna. The new facility will be used for standardization of isotopes and preparation of radioactive standards; calibration and adaption of measuring equipment; quality control of special materials for nuclear technology; and measurement and analysis in connection with the agency's safeguards and health and safety program. Its services will be used by member states. The United States has offered to donate $600,000 to be applied against the cost of constructing and equipping the laboratory.

* * *

A booklet that highlights the extent and organization of Soviet research and development in the Far North and discusses the nature of Russia's over-all system of scientific and technological institutions has just been released by the Arctic Institute of North America. The 100-page publication is *Institutions of the U.S.S.R. Active in Arctic Research and Development,* by Vladas Stanka, a member of the research staff of the Arctic Institute's Arctic Bibliography Project. In all, 374 Soviet organizations and institutions directly or indirectly concerned with northern science and progress are listed, many with details regarding their fields of activity, organizational setup, and publications. An additional listing gives names and locations of 107 polar stations known to have been in operation in 1956.

* * *

A working group has been appointed to conduct major long-range scientific explorations of the moon's surface and environment, the National Aeronautics and Space Administration has announced. Headed by Robert Jastrow of NASA headquarters, the group is one of a number of working units whose members will follow through on experiments and correlate forthcoming satellite and space probe projects. Establishment of working groups in the fields of satellite beacons and orbiting astronomical observatories has been previously announced.

Scientists in the News

SIDNEY BURWELL, professor of medicine at Harvard University Medical School, will retire 31 August to become Levine professor emeritus of medicine, after 40 years of academic service. A distinguished physiologist in the cardiovascular field, Burwell was appointed dean of the faculty of medicine and research professor of clinical medicine at Harvard in 1935, where he remained until 1949. He then returned to the research laboratory at the Peter Bent Brigham Hospital which he had maintained during his deanship at Harvard. He also organized a Medical Service and a Medical Research Laboratory at the Boston Lying-in Hospital. From 1927 until 1935 he was head of the department of medicine at Vanderbilt University Medical School. Burwell is coauthor of *Heart Disease and Pregnancy*. After his official retirement he plans to write the history of the Harvard University Medical School.

THOMAS PARRAN, president of the Avalon Foundation, New York, and former Surgeon General of the U.S. Public Health Service; and WARREN WEAVER, vice president of the Rockefeller Foundation and former president of the American Association for the Advancement of Science, have been elected to honorary membership in the National Association of Science Writers.

ROME F. GELLER, who retired in 1956 as chief of the porcelain and pottery section of the National Bureau of Standards, has received the Albert Victor Bleininger Award. The award, presented annually, is the highest honor conferred in this country for outstanding achievement in the field of ceramics.

GEORGE G. SIMPSON, curator of fossil mammals and birds at the American Museum of Natural History in New York, will join the faculty of Harvard University this summer as Alexander Agassiz professor of vertebrate paleontology in the Museum of Comparative Zoology. He will devote himself to research and will have no teaching or curatorial duties.

FELIX BLOCH, physicist at Stanford University and cowinner of the Nobel Prize in 1952, will lecture at Hebrew University, Jerusalem, under a Fulbright scholarship on a year's leave of absence, beginning in September.

Vice Admiral HYMAN G. RICKOVER has received a special gold medal, authorized by Congress, in recognition of his work in directing the development and construction of the world's first nuclear-powered ships and the first large-scale nuclear power reactor devoted exclusively to the production of electricity. Senator Clinton P. Anderson, chairman of the Joint Committee on Atomic Energy, presented the medal at a public session of the Joint Committee.

GRACE A. GOLDSMITH, professor of medicine at Tulane University Medical School, received the $1000 Osborne-Mendel Award of the Nutrition Foundation at the annual dinner of the American Institute of Nutrition. On the same occasion HARRY E. STEENBOCK, emeritus professor of biochemistry of the University of Wisconsin, received the $1000 Borden Award in Nutrition.

J. BJERKNES, professor of meteorology at the Bergen Geofysiske Institut, Norway, and at the University of California, Los Angeles, was awarded the International Meteorological Organization Prize for 1959 at a special session of the Executive Committee of the United Nations. The prize ($1200 and a gold medal) was established in 1955 by the World Meteorological Organization.

MURRAY GELL-MANN, professor of physics at the California Institute of Technology, has been named the 1959 winner of the Dannie Heineman Prize for Mathematical Physics. The $2500 award will be made during the spring meeting of the American Physical Society, 1 May, in Washington.

HADLEIGH MARSH, veterinary pathologist at Montana State College, and consultant to the U.S. Department of Agriculture, has received the third annual Distinguished Service Award of the Animal Health Institute. The award, which consists of $1000 and an engraved plaque, was presented during the annual meeting of the Animal Health Institute in Washington, D.C.

ARTHUR L. SCHIPPER, member of the staff of the Oak Ridge Institute of Nuclear Studies, has joined the National Institute of Health as a biologist in the research grants branch of the National Cancer Institute.

WALTER R. BEAM, manager of advanced microwave development in the Electron Tube Division of the Radio Corporation of America, has been named head of the department of electrical engineering at Rensselaer Polytechnic Institute, effective 1 July. Beam will succeed HAROLD N. TREVETT, who has been acting head of the department since 1955.

LAWRENCE H. GAHAGAN, former assistant professor of psychology at the University of California, Los Angeles, has been appointed head of the department of psychiatry and neurology at the Beverly Hills Medical Clinic, Beverly Hills, Calif.

GEORGE H. MICKEY, chairman of the department of zoology at Louisiana State University, has been appointed dean of the graduate school. He succeeds RICHARD J. RUSSELL, who has been appointed director of the Coastal Studies Institute.

GEORGE P. FULTON, chairman of the department of biology at Boston University College of Liberal Arts, has been named the first Shields Warren professor. The professorship was established in honor of Shields Warren, noted pathologist and chairman of the executive committee of the Boston University board of trustees, on his 60th birthday.

JOSEPH L. McCARTHY, professor of chemical engineering at the University of Washington, has been appointed dean of the university's graduate school, as of 1 July. He will succeed HENRY A. BURD, professor emeritus in marketing, who has been acting dean since September 1955.

EDWARD DIAMOND has resigned as associate general counsel of the Atomic Energy Commission, and has joined the Stromberg-Carlson Division of the General Dynamics Corporation at Rochester, N.Y., as secretary and general counsel.

Recent Deaths

WILLIAM J. BAUMGARTNER, New York; 87; retired in 1949 as professor of zoology of the University of Kansas; staff member of the Puget Sound Marine Station, University of Washington, 1908–15; had taught at the University of Chicago; 12 Apr.

JOHN P. DELANEY, Baltimore, Md.; 64; emeritus professor of physics at Loyola College; led a student expedition to Athens, Palestine, and Turkey in 1933; president of the eastern section of the American Association of Jesuit Scientists; 11 Apr.

GERHART K. GROETZINGER, Baltimore, Md.; 51; principal scientist at the RIAS Division of the Martin Company since 1956; had been associated with the University of Illinois, Ohio State University, the Enrico Fermi Institute for Nuclear Studies at the University of Chicago, the Lewis Laboratory of the National Advisory Committee on Aeronautics, and the Los Alamos Laboratory of the Atomic Energy Commission; faculty member of the University of Vienna, 1931–38; 30 Mar.

ADOLPH JACOBY, New York; 71; retired in 1952 as director of the Health Department's Bureau of Social Hygiene, after having been with the department for 36 years; had been associate clinical professor of obstetrics at New York University Medical School; had taught at Post-Graduate Medical School and at Columbia University; 9 Apr.

DAVID A. KREIDER, Stamford, Conn.; 88; associate professor emeritus of physics of Yale University; was affiliated with the university from 1893 until his retirement in 1936; 9 Apr.

J. BRADLEY LONG, San Francisco, Calif.; 36; assistant clinical professor of medicine at the University of California and vice president of the San Francisco Heart Association; 9 Apr.

JAMES E. MAYNARD, Syracuse, N.Y.; 60; petrographer and economic geologist; professor of geology at Syracuse University, where he had been a member of the staff since 1930; 9 Apr.

GERALD H. MATTHES, New York; 85; retired consulting engineer and a specialist in flood control; inventor of the tetrahedral block revetment for river banks, the topographic slide rule for plane-table surveying, and a mechanically controlled aerial camera; 8 Apr.

JOSEPH STAMBUL, Philadelphia, Pa.; 64; cardiologist; had performed research in the field of atherosclerosis for the last 20 years; author of *The Mechanisms of Disease*; 11 Apr.

MARVIN J. UDY, Niagara Falls, N.Y.; 66; metallurgist; vice president and consultant of Strategic–Udy Processes, Inc.; developed new methods for separating or refining chromium, nickel, cobalt, and bismuth; 11 Apr.

Book Reviews

The Living Races of the Sahara Desert. Papers of the Peabody Museum of Archaeology and Ethnology. vol. 28, No. 2. L. Cabot Briggs. Harvard University, Cambridge, Mass., 1958. xii + 217 pp. Illus. $7.85.

The greatest desert in the world, often popularly pictured as three million square miles of rolling sand dunes, uninhabited except for transient camel caravans, a few bands of brigands, and some venturous parties of petroleum prospectors, actually supports today a permanent though not always peaceful population estimated at about two-and-a-half million. L. Cabot Briggs reports that these desert dwellers descend from ancient peoples whose scattered remains attest a long period of occupation, and whose racial affiliations are gradually being worked out. North and Saharan Africa has its examples of fossil pithecanthropoids, neanderthaloids, and primitive *sapiens* types. However, the relative ages and the cultural associations of some of these types are by no means firmly established.

The author paints a picture of Saharan life made especially vivid because he has drawn upon the results of many kinds of research. We learn that in the rolling sandy plains and mountain masses which fill two-thirds of the Sahara (only the remaining third is dune-covered), wells and *foggaras* (underground channels) supply water, "often unpleasantly rich in magnesium and calcium salts, and even in sulphuric acid," for date and vegetable gardens and small grain fields, as well as for man and his domestic animals. Though the portion of the land under cultivation is only 0.4 percent in the north, decreasing to 0.0025 percent in the south, Saharan agriculture can be traced back to Neolithic times and includes cultivation of the date and of wheat, millet, and numerous other important food plants. Wild grasses as well as forage crops permit the grazing of herds of goats, sheep, and camels, and these in turn support their nomadic human masters, who depend in large part upon milk as their staple food. The use of domestic animals in the Sahara can also be traced back to times before the beginning of the Christian era; there is evidence that cattle and horses were kept before the Sahara became so dessicated, and it appears likely that indigenous camels may have been domesticated only when it was no longer possible to keep cattle and horses. In spite of the variety of foodstuffs produced, the Sahara is no land of milk and honey; almost the entire population—in particular the nomads, who depend most upon livestock—is reported to suffer from malnutrition and deficiency diseases.

Among the peoples of the Sahara today are to be found sedentary negroid Haratin sharecroppers, working lands owned by light-skinned Teda and Tuareg nomads, for the landed nobility here much prefer a wandering life in regions of problematical water supply and uncertain rations to a sedentary, albeit less hazardous, existence around the oases.

The light-skinned Berber peoples of North Africa have established tight-packed commercial centers and depend as much upon trading as upon farming for a livelihood, while the shaggy-headed and dusky-skinned Moors of the western extremity of the Sahara rely very largely upon their herds but are able to obtain some vegetable foods through trade. In recent decades, however, this type of life has given way to a greater dependence upon cultivation throughout the Sahara.

This is an area of many amazing cultural anomalies. Some which particularly whet my curiosity are the traces of matrilineal organization in the social systems of pastoral Moors, Tuaregs, and Tedas, as well as of the possibly related Bejas of the eastern Sudan. This is not at all in accord with theories concerning the necessary patrilineality of herding peoples whose men control and care for the livestock, and it invites study of both function and history.

The two-party political organization —another feature of many Saharan communities—may be the expression of a basic social force which, for some reason, emerges with particular clarity in the Saharan physical-cultural environment. This deserves further attention, though G. P. Murdock has already offered an explanation in which Saharan political moieties are shown to be defensive alliances ["Political moieties" in *The State of the Social Sciences,* Leonard D. White, Ed. (Univ. of Chicago Press, 1956), pages 133–147]. Murdock's article may have appeared too recently for inclusion in Briggs' list of references, but Briggs does not cite the earlier works by J. Chavanne and R. Montague to which Murdock refers, both of which deal with this peculiar feature of Saharan society.

Although Briggs' avowed purpose is to summarize "our present knowledge of the ecology and racial characteristics of the living tribes of the Sahara Desert," the greater part of the book is given over to a résumé of the archeological and historical background and the ethnological present of the Saharan peoples. These considerations no doubt have bearing upon physical type, and ethnologists will be happy to have the available materials so succinctly compiled for them. There are many data here, and the gaps which remain emerge clearly. Yet, the connections between environment and mode of life on the one hand and physical type on the other are presented in the main as fortuitous associations, and no new suggestions of causal relationship are proposed.

Since the work does, in fact, come close to being a comprehensive anthropological survey of the Saharan peoples in the widest sense, we may be permitted some suggestions with respect to what might have been added in order for it to attain that end. A major lack, I felt, is the absence of a map of the Saharan peoples; a sketch of the vegetation zones also would be useful. Although the major linguistic groups are charted, there is little discussion of the linguistic classification, and little use is made of it. For instance, Briggs notes that in somatic features the Teda are negroid but that they resemble the lighter-skinned Berbers in blood type. Therefore, he surmises, the Teda may be the descendants of an ancient Saharan stock with later admixture of negroid elements; in fact, the Teda, Tuareg, and Moors are "all remnants of a single far-flung population that was once essentially homogeneous physically and culturally, too." But the linguistic evidence is not here taken into account, for it clearly separates the Teda in this important aspect of culture from the other inhabitants of the Sahara, all of whom speak related languages. Granted that culture, including language, is by no means an invariable indicator of racial relationships, nevertheless the linguistic discontinuity demands explanation.

Briggs' summary of the physical types is straightforward and calls for little comment in a review. The data, often scanty, are compiled from many sources and presented in convenient tabular form, together with statistical measures of dispersion when available. A short and clear verbal description of each type is provided. The misleading terms *Hamitic* and *Half-Hamite,* which confuse race and language in spite of attempts to define the types from a physical standpoint, are avoided in the

technical racial analyses, though they are employed in the chapter on the prehistoric background.

In his assessment of the physical types and their interrelationships, Briggs places much weight on resemblances and differences in the A, B, O blood group percentages of populations; but this is a feature controlled by alleles of a single gene, and alone it is hardly an adequate basis for determining racial affiliations. Although the thesis that genetic features of a population are subject to change through mutation and selection is acknowledged in the introduction, the only explanation offered for resemblances in A, B, O blood group percentages in the racial analyses themselves is in terms of admixture. Thus, Briggs accepts a high incidence of type B blood as suggestive of negro admixture among the Moors, and as "unquestionably" due to negroid admixture among the Chaamba. Furthermore, conjecture as to how miscegenation might have taken place through liaisons of light-skinned aristocrats with their negroid slaves or servants is followed by the supposition that persons higher in the social scale are probably more mixed than those less fortunate, since the former are more likely to keep servants or slaves. But this fanciful suggestion is contradicted by Briggs' statement, later on the same page, that the Zenata, an Arab people in the northern Sahara, are increasingly negroid from top to bottom of the socioeconomic scale!

Quibbling aside, anthropologists will be grateful for this book—certainly the best summary in English to date of the Saharan peoples and their cultures. Many French, German, and English sources have been utilized, and the information has been weighed against the author's own extensive field observations. A fine set of illustrations of typical Saharan living arrangements and portraits of typical physical types completes the volume.

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Polarography. In medicine, biochemistry, and pharmacy. M. Brezina and P. Zuman. Translated from the Czech by S. Wawzonek. Interscience, New York, rev. English ed., 1958. xviii + 862 pp. Illus. $19.50.

It is fitting that an English edition of this treatise should appear shortly before an International Congress of Polarography is to be held in London. It illustrates the broadness of application that this electrochemical method has attained since its discovery 35 years ago by J. Heyrovsky, who has contributed the foreword to the volume. It is to be hoped that editorial reaction will no longer be, "a rather restricted field" or "not the method of choice," and so on.

The early development of polarography was largely confined to Czechoslovakia and was reported in the Collection of Czechoslovak Chemical Communications. The writings of Otto Müller and of Kolthoff and Lingane have now acquainted the American scientist with the literature in general.

Brezina and Zuman collected and digested all the polarographic literature on medicine, biochemistry, and pharmacy, and from their edition (in Czech), S. Wawzonek of the department of chemistry of the State University of Iowa developed the English edition. In the process he extensively enlarged and revised the original. There are 2000 references, twice the number in the Czech edition. The subject matter included in the book is broad enough to make it valuable to any biologist using polarography.

The format of the book is of the fine quality characteristic of the publisher. Unfortunately, the English edition lacks the author index included in the German edition, but a list of references follows each chapter, and a bibliography of monographs and reviews is included at the end of the book. A frontispiece shows J. Heyrovsky with R. Brdicka and the Nejedly polarographic apparatus. There are numerous clear diagrams of apparatus and typical polarograms of substances of biological interest. A collection of data on buffers and the half-wave potentials of compounds occupies 58 pages in part 7. The theoretical aspects of polarography are not developed, but the reader is referred to other sources for this information; only four pages are given to the "Nature of polarographic analysis."

The authors' objective is "to show laboratory workers the possibilities of polarographic methods as well as to provide them with a practical manual in which entire procedures are described in great detail."

The main parts of the book cover the determination of (i) inorganic compounds, (ii) organic compounds, (iii) proteins, (iv) enzymes, and (v) polarographic maxima. In each case the procedures for analysis in biological material are given—for example, for determination of magnesium in serum, epidermis, plants, and water. Examples of quinones considered are phthiocol, juglone, and adrenochrome.

In the section on proteins the work of Brdicka and others on the catalytic waves of protein and their diagnostic value in cancer and various other diseases and the titration of active groups in protein are developed in detail. The chapter on enzymes is but 15 pages long and deals mainly with hemin, catalase, and milk enzymes. The sections on hormones, vitamins, alkaloids, and so forth contain many valuable analytical procedures. The section on *maxima* describes the analysis of many biological fluids by measurement of their maxima suppressive activity; for example, the aqueous humor of the eye has a surface activity of protein 16 times greater than the value for serum protein.

The authors' style is clear and to the point. Enough detail is given with respect to any substance occurring in biological material so that the polarographic analytical possibilities are apparent. The book should be a useful source of information to anyone concerned with experimental biology or medicine in the broadest sense.

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Manuel de Paléontologie Animale. Léon Moret. Masson, Paris, ed. 4, 1958. 771 pp. Illus. Paper, F. 3200.

Like the third edition, published in 1953, this is a reprinting, without changes in the text. New information is incorporated in an "Addendum," which in the present edition amounts to some 34 pages and constitutes an annotated bibliography of recent work, with special emphasis on French contributions.

The book is well designed as an introduction to general paleontology. Nine chapters deal with the principal invertebrate phyla, five with the vertebrates. Illustrations are line drawings and are more numerous than the stated 274 would suggest, for many of the numbered figures are comprised of several parts.

Each section and each chapter begins with a general statement as to classification, morphological terms, and so forth, followed by more detailed reviews of important family groups and, usually, by a discussion of evolutionary trends, phylogeny, and stratigraphic significance. That the author should draw most heavily upon the work of his fellow countrymen in the literature cited and the classifications adopted is perhaps inevitable. For at least one group—the pelecypods known as rudists—this is a happy circumstance: the 20 pages devoted to the pachyodonts form probably the best available modern summary on these complex bivalves. The 62 pages on Foraminifera provide a compact and usable summary. Zoologists, however, may deplore the undifferentiated phyletic group *"Les Vers."* In this connection, also, one must point out that the author has perpetuated a common confusion by placing the annelid genus *Tubulostium* [now generally considered

a synonym of *Rotularia*] under the gastropod family Vermetidae and labeling the figure as an aberrant turritellid.

Names for taxa of family group level and higher are given in a French vernacular form; this would be a serious disadvantage if the book were to be used in America as a primary text. However, as a supplementary reference work, it seems worthy of commendation.

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Arctic Bibliography. vols. 6 and 7. Prepared for and in cooperation with the Department of Defense, under the direction of the Arctic Institute of North America. Marie Tremaine, Ed. Department of Defense, Washington, D.C., 1957 (order from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.). xiii + 1208 pp.; xiii + 1071 pp. Maps. $4.50; $4.25.

With the publication of the seventh volume (fourth supplement), this excellent, specialized, annotated bibliography now covers 43,464 entries on arctic subjects. The literature is reported up to 1955. The general task of the project was fully explained by the chairman of the directing committee, Henry B. Collins, Jr., some years ago in *Science* [**119**, 3A (26 March 1954)] after the publication of the basic bibliography [volumes 1–3 (1953) (4478 pages)] containing entries 1 to 20,003 and the subject index.

Some words may be said about volumes 4 and 5, announced by Collins but not reviewed in *Science*. These two volumes cover the literature issued in the years 1950 to 1953, inclusive, and contain the entries Nos. 20,004 to 33,125. They form the first two supplements to the basic bibliography and include also publications issued earlier than 1950 but for various reasons not listed in the three first volumes.

Volume 6, published in 1956, reports the literature on arctic subjects published in 1954, and includes, also, earlier studies dating back to before the 19th century which were omitted previously. It covers entries 33,126 to 38,410. Volume 7, issued in 1957, includes the arctic publications for the year 1955 (entries 38,411 to 43,464) and also reports earlier literature not included in the previous volumes.

The whole bibliography is an extremely impressive example of fine and conscientious teamwork, performed under the direction of Marie Tremaine. She and the members of her staff are to be heartily congratulated.

The four supplements as well as the three volumes of the basic bibliography enumerate the publications in alphabetical order, by author, including the first and second names of the authors and dates of birth and death. Where a publication has more than one author, careful cross references are given to the name of the first author, the title (abbreviated), and the running entry number. Though the different subjects are mixed, the extended and complete indexes enable the user to find every subject very easily. Titles of publications are given in the original language (languages using letters other than roman have been transliterated) and in English translation. In spite of the innumerable titles in foreign languages that are included, there are practically no mistakes in spelling. In this respect the *Arctic Bibliography* can be cited as a model for similar undertakings. German users will especially appreciate the fact that the nouns in German titles are not "decapitalized," as they often are in such publications. It is really astonishing to find that even words which had to be broken are divided according to the rules of the language in question. References to periodicals and (for separate publications) to editors are given in an extremely clear manner; included are the full title of the periodical, the number of volume and part, the number of pages, plates, figures, and maps, the year (for journals), and the editor's name and the place and date of publication (for separate publications). Misleading abbreviations have been avoided; this facilitates finding the original publication, especially since at least one library in the United States where the publication has been seen by the analyst is mentioned for each report. (These libraries are listed at the beginning of every volume.) The annotations are very extensive and give, generally, a good idea of the subjects treated in the publications.

This bibliography is still incomplete, doubtless because of the great task involved in reporting the literature for such a large geographical area, but each new volume serves to bring it nearer completion. Volume 5 contains a table showing the names and the subjects treated by the members of the staff of the Arctic Bibliography project; in the previous volumes these were mentioned only in the introduction. Starting with volume 6, the index gives the titles only in English, whereas the indexes of the previous volumes gave them in the original language. This change is a contribution to clarity and facilitates use of the index. In the two recent volumes, 6 and 7, the reports are still more extensive than in the previous volumes, and therefore even more useful.

In future volumes perhaps an effort might be made to complete the author citations with respect to first and second names and to dates of birth and death; these have been left out in many cases in the published volumes. Finally, one might be interested to know the name of the reporter of a publication; he might be cited, by his initials, at the end of the report.

Without any exaggeration, the *Arctic Bibliography* may be called a milestone in its field and may be taken as an excellent example for all similar undertakings. Especially for scientists it is an indispensable reference work, due to its broad basis, and not only for those who are students of the arctic regions. It would be extremely useful if similar projects could be undertaken for other areas, for the antarctic and the tropics in particular.

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Semiconductors and Phosphors. Proceedings of the International Colloquium, 1956. M. Schön and H. Welker, Eds. Interscience, New York; Vieweg and Sohn, Braunschweig, Germany, 1958. viii + 864 pp. Illus. $16.50.

This proceedings volume of the international colloquium held at Garmisch-Partenkirchen in 1956 presents the complete text of the 100 papers contributed by American, Dutch, English, French, German, and Russian researchers. The papers cover a wide field, from general properties of semiconductors and phosphors to specific problems, such as thermoelectric phenomena, incorporation of foreign atoms in phosphors, trapping mechanisms, hole motion, magnetic properties, and energy-transfer problems.

The articles, written either in English, French, or German, offer interesting and stimulating reading and will be highly welcomed by researchers and all other scientists interested in this rapidly expanding field.

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The Green Flash and Other Low Sun Phenomena. D. J. K. O'Connell. (Vatican Observatory publication.) North Holland, Amsterdam; Interscience, New York, 1958. 192 pp. Illus. $6.

The green flash, or the green ray as it is sometimes called, is a phenomenon resulting from atmospheric refraction. The last bit of the setting sun or the first tiny segment of the rising sun may be a vivid green or at times a bright blue. In presenting an accurate and detailed account

of this interesting phenomenon, O'Connell, director of the Vatican Observatory, has provided an excellent book which will be welcomed by scientists and laymen alike. The author lays to rest, gently and finally, the theory which has been supported by many psychologists, and even by some astronomers, that the phenomenon is purely physiological in origin. Excellent color photographs made at the Vatican Observatory, both at sunset and at sunrise, seem to settle the question beyond doubt.

The reproductions of photographs taken by C. Treusch—80 in color and about 140 in black and white—are especially to be recommended. Only a fraction of them are of the green flash, but all of them concern low sun phenomena, notched and banded suns, and so forth —effects of irregular atmospheric refraction near the horizon. The color photographs of the green flash are particularly impressive when one realizes that, on the average, the phenomenon is visible only a few times a month and then only for a second or so. I have seen the green flash many times in the last 20 years, and I have often tried to photograph it in color, but none of my color prints will match the best of Treusch's.

The green flash is not as well known as it should be. It is not to be found in the indices of the elementary astronomy texts on my library shelves, nor is it to be found under "green flash" or "green ray" in recent editions of the *Encyclopedia Britannica* or *Encyclopedia Americana,* although it is included in the *Great Soviet Encyclopedia.* Sea captains, retired after a half century or more of service, have told me that it was only after retirement that they had heard of the green flash and had observed it.

There is an excellent bibliography of 313 entries, in two sections—"Theory" and "Observations." Each of these sections is arranged alphabetically by author. The next generation will doubtless be better informed on the green flash than this one is.

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Dairy Cattle, Judging and Selection. William W. Yapp. Wiley, New York; Chapman and Hall, London, 1959. x + 324 pp. Illus. $5.95.

In this text on the physical characteristics of dairy cattle, the author portrays associations between type of cattle and milk production. Standards of excellence and common defects in dairy cattle are well portrayed by the illustrations.

A considerable portion of the text is devoted to the author's philosophy concerning the importance of type appraisal and the contributions it has made to the development of the dairy production industry. The techniques of good judging are thoroughly discussed. Procedures for handling the show ring are set forth clearly.

This book will be of interest to the experienced dairyman, the student, and the newcomer to the field.

R. F. DAVIS
Dairy Department,
University of Maryland

New Books

Abelian Varieties. Serg Lang. Interscience, New York, 1959. 268 pp. $7.25.

Animal Life. Lorus J. Milne and Margery Milne. Prentice-Hall, Englewood Cliffs, N.J., 1959. 382 pp. $6.95.

Birth of an Island. Millicent E. Selsam. Harper, New York, 1959. 47 pp. $2.50 (juvenile book).

The Cellular Slime Molds. John Tyler Bonner. Princeton Univ. Press, Princeton, N.J., 1959. 158 pp. $4.

The College Influence on Student Character. An exploratory study in selected colleges and universities made for the Committee for the Study of Character Development in Education. Edward D. Eddy, Jr. American Council on Education, Washington, D.C., 1959, 197 pp. $3.

Constitutional Diagrams of Uranium and Thorium Alloys. Frank A. Rough and Arthur A. Bauer. Addison-Wesley, Reading, Mass., 1959. 159 pp. $5.

The Content and Style of Oral Literature. Clackamas Chinook myths and tales. Melville Jacobs. Univ. of Chicago Press, Chicago, 1959. 293 pp. $5.

Curare and Curare-Like Agents. D. Bovet, F. Bovet-Nitti, G. B. Marini-Bettolo, Eds. Elsevier, Amsterdam, Netherlands, 1959 (order from Van Nostrand, Princeton, N.J.). 489 pp. $15.75.

Elements of Physical Metallurgy. Albert G. Guy. Addison-Wesley, Reading, Mass., 1959. 544 pp. $9.50.

Family Worlds. A psychological approach to family life. Robert D. Hess and Gerald Handel. Univ. of Chicago Press, Chicago, 1959. 319 pp. $5.

The Fearful Choice. A debate on nuclear policy conducted by Philip Toynbee. Wayne State Univ. Press, Detroit, Mich., 1959. 112 pp. $2.50.

Function of the Human Body. Arthur C. Guyton. Saunders, Philadelphia, Pa., 1959. 595 pp. $7.50.

The Guidance Function in Education. Percival W. Hutson. Appleton-Century-Crofts, New York, 1958. 697 pp. $6.

Histochemical Technique. W. G. Bruce Casselman. Methuen, London; Wiley, New York, 1959. 205 pp. $3.25.

A History of Western Morals. Crane Brinton. Harcourt, Brace, New York, 1959. 512 pp. $7.50.

Immunity and Virus Infection. Symposium held at Vanderbilt University School of Medicine. Victor Najjar, Ed. Wiley, New York; Chapman & Hall, London, 1959. 270 pp. $10.50.

An Introduction to Advanced Dynamics. S. W. McCuskey. Addison-Wesley, Reading, Mass., 1959. 271 pp. $8.50.

Introduction to Nuclear Power Costs. Arnold Rochman. Simmons-Boardman, New York, 1959. 50 pp. $2.95.

Japan, China, and the West. The economics of competitive coexistence. H. Michael Sapir. National Planning Assoc., Washington, D.C., 1959. 79 pp. $2.

The Logic of Scientific Discovery. Karl R. Popper. Basic Books, New York, 1959. 480 pp. $7.50.

Methods Based on the Wiener-Hopf Techniques for the Solution of Partial Differential Equations. B. Noble. Pergamon, New York, 1958. 256 pp. $10.

Méthodes numériques interpolation—dérivées. J. Kuntzmann. Dunod, Paris, 1959. 269 pp. F. 3600.

Millions of Years Ago. Prehistoric life in North America. Edwin H. Colbert. Crowell, New York, 1959. 153 pp. $2.75.

Mono- and Sesquiterpenoids. vol. II. P. de Mayo. Interscience, New York, 1959. 327 pp. $7.50.

A New Design for Living. Ernest Holmes and Willis H. Kinnear. Prentice-Hall, Englewood Cliffs, N.J., 1959. 249 pp. $3.95.

Obligatory and Facultative Insects in Rose Hips. Their recognition and bionomics. Biological Monogr. No. 26, W. V. Balduf. Univ. of Illinois Press, Urbana, 1959. 194 pp.

1001 Questions Answered about the New Science. David O. Woodbury. Dodd, Mead, New York, 1959. 371 pp. $6.

The Onset of Stuttering. Research findings and implications. Wendell Johnson *et al.* Univ. of Minnesota Press, Minneapolis, 1959. 254 pp. $5.

Orbit. A picture story of force and motion. Hy Ruchlis. Harper, New York, 1958. 147 pp. $2.75.

Organic Peroxides in Radiobiology. R. Latarjet. Pergamon, New York, 1958. 153 pp. $9.50.

Ozeane Salzlagerstätten. Grundzuge der Entstehung und Metamorphose ozeaner Salzlagerstätten sowie des Gebirgsverhaltens von Salzgestiensmassen. Hermann Bochert. Gebrüder Borntraeger, Berlin, 1959. 245 pp. DM. 48.

The Plasma Proteins. Clinical significance. Paul G. Weil. Lippincott, Philadelphia, Pa., 1959. 144 pp. $3.50.

Readings in General Psychology. Paul Halmos and Alan Iliffe, Eds. Philosophical Library, New York, 1959. 260 pp. $6.

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Seeds and More Seeds. Millicent E. Selsam. Harper, New York, 1959. 62 pp. $2.50 (juvenile book).

The Silent Language. Edward T. Hall. Doubleday, Garden City, N.Y., 1959. 240 pp. $3.95.

Wasserbestimmung mit Karl-Fischer-Lösung. Ernst Eberius. Verlag Chemie, Weinheim, 1958. 179 pp. DM. 19.60.

What's Wrong with U.S. Foreign Policy. C. L. Sulzberger. Harcourt, Brace, New York, 1959. 255 pp. $4.50.

The Yearbook of the Royal Society of London, 1959. Royal Society of London, London, 1959. 287 pp.

Reports

Contact Occluders: a Method for Restricting Vision in Animals

Abstract. Preliminary observations show that contact occluders can be used to produce temporary "blindness" in monkeys. This report also describes how such occluders can be made.

Blocking visual input to one or both eyes is involved in experiments on the effects of prolonged visual deprivation (*1*), interocular transfer of visual discrimination habits (*2*), spontaneous recovery of visual function following brain damage (*3*), and also in experiments on senses other than vision where the possibility of the animals' responding to visual cues must be excluded (*4*). For most of these experiments it is essential not only to restrict the animals' vision, but later to restore it. In searching for a simple and reliable way of inducing such temporary "blindness" in monkeys, we have explored the feasibility of occluding vision by inserting plastic cups under the monkeys' eyelids (see Fig. 1). These "contact occluders" are similar to the contact lenses used for correcting vision in man; but for experimental work with animals they must be relatively larger than contact lenses so that the animals cannot remove them, and they must remain in place for considerably longer periods of time without causing injury to the eyes. In our experience, contact occluders have passed both tests surprisingly well.

At first, transparent eyecups of different sizes were tried to determine which would stay in place and whether or not any pathology would develop. The monkeys regularly removed those that were less than about 18 to 20 mm in diameter. The larger cups, however, were not removed, and the only ocular abnormality that could be detected was an occasional collection of cloudy lacrimal secretion which would soon disappear, presumably as a result of sufficient eye-movement.

A pair of large-sized translucent cups was then inserted in the eyes of an adolescent monkey. These cups remained in place for 9 months before the monkey succeeded in removing one of them. The animal is shown in Fig. 1, the picture which was taken after it had been wearing the occluders for 6 months. During the period of induced "blindness," this animal was trained to perform a delayed-alternation task, a tactual roughness discrimination, and an auditory discrimination. Also, shortly before its vision was restricted, it had been trained to make a fairly difficult discrimination between two visual patterns. When the contact occluders were removed 9 months later it showed complete retention of the visual habit. An ophthalmological examination (*5*) made at this time revealed some vascularization of the deeper corneal layers and, also, a few small cloudy patches scattered over the corneas. The corneal epithelium of both eyes was intact, however, and the irises, anterior chambers, and pupils appeared to be normal. (Although the small amount of corneal abnormality in this animal did not interfere with its retention of the visual habit, the presence of other more subtle visual defects could have easily escaped detection. The need for further work along these lines is clearly indicated.)

Most recently, four monkeys were run in an experiment which involved visual discrimination learning with left and right eyes on alternate weeks. At the end of each week the animals were caught and held while the contact occluders were shifted from one eye to the other. Anesthetics were not necessary since removing and reinserting an occluder, which took only about 2 minutes, did not appear to be a traumatic procedure. Each of the animals underwent this procedure a dozen times, and there was no evidence of gross ocular damage in any of them. An ophthalmological examination performed on one of the animals yielded results essentially similar to those described above.

While these preliminary observations have been limited to the use of contact occluders for preventing vision in monkeys, it would seem that the method could be applied to other animals, and to other problems, as well (*6*). For those who may be interested in working with this technique the following description of how occluders can be made may be helpful.

Occluders can be formed from any thermosetting plastic such as Plexiglas or Lucite. We have used sheets ranging in thickness from 1/64 to 1/16 inch with about equal success. Opaque black plastic is available if it is necessary to exclude all light, but milk-white translucent material is useful if it is desired only to prevent pattern vision. Completely transparent plastic serves as an excellent control for the occluders.

While it is not essential that the occluders fit as perfectly as do the contact lenses for ophthalmic use in humans, their curvature should conform reasonably well to the shape of the animal's eyeball. Precise measurements of the corneal and scleral curvature can be made with the ophthalmometer, but it is probably sufficient to approximate these curves from a paraffin or plaster mold made from a freshly enucleated eye. The small variation in the size and shape of eyeballs of monkeys weighing between 6 and 16 pounds has not caused any difficulty.

The form with which the contact occluders are shaped is made of brass or aluminum alloy about 20 mm in diameter, or 1-inch stock if that is the nearest size available. One end is turned in a lathe to fit the eye-mold as closely as possible and then carefully polished. Since any roughness or irregularity of the form will be transmitted to the plastic, the polishing should be thorough. The female part of the form consists simply of a short section of hollow metal tubing, or a hole in a piece of sheet metal, the diameter of the hole depending on the size of the occluder desired. We have found that for monkeys the occluders should be about 18 to 20 mm in diameter, which is about as large as can be inserted under the lids without difficulty.

The plastic material is cut into small squares (about 30 mm on a side) by scoring it heavily with a sharp tool and then breaking it. A piece is grasped at its corner with forceps and waved through a low flame until it becomes soft and pliable. If it is heated too quickly or too much, bubbles may appear, destroying the smooth surface. When it is sufficiently soft for molding the plastic is quickly laid over the hole, and the eye-shaped form is firmly pressed into it and held for a minute or two while the plastic hardens. Excess material is then trimmed off by cutting, grinding, or filing, and the edge is carefully rounded and smoothed. The final

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

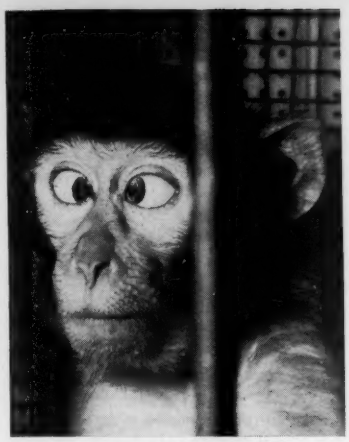

Fig. 1. Monkey with occluders.

operation is polishing, which is done on a soft cotton buffing wheel with tripoli or some other polishing compound. If no sharp edges or roughness are found, the occluders are ready for cleaning and use.

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5. We thank Ludwig von Sallmann, of the National Institute of Neurological Diseases and Blindness, for performing the examinations.
6. We have since learned from Austin Riesen that Leo Ganz, in the department of psychology at the University of Chicago, has been independently developing this technique for use with cats to produce, among other things, a colored Ganzfeld (!).

17 December 1958

Spatial Distribution of Phoronopsis viridis Hilton

Abstract. Individuals of the species *Phoronopsis viridis* Hilton exhibit an even distribution within their colonies. The distance between nearest neighbors is probably related to the space required for the operation of the lophophore. Distributions of other marine invertebrates are discussed briefly, together with the paleoecological implications of such knowledge.

The horizontal spatial distribution of *Phoronopsis viridis* Hilton was studied in three intertidal areas on the shores of Tomales Bay, California (*1*). Observations on the nearest-neighbor relationships of *Phoronopsis* were taken and analyzed after the method proposed by Clark (*2*). Individuals of this species occur in clusters of thousands throughout the areas studied. While the clusters or colonies possibly develop as a response to very local environmental features, field examination revealed no obvious differences in the sediment at colonized and noncolonized sites. The first-nearest-neighbor relationships were observed for 384 individuals chosen at random within colonies.

The proportions of first-nearest-neighbor relations that are reflexive in each of the samples are shown in Table 1. The proportions for each locality are not significantly different from one another when tested by chi-square [$Pr(X^2 \geqq 1.004) > 0.05$]. The number of reflexives (218) in the pooled data from all three sites was found to be significantly less than that expected for a random distribution (239) [$Pr(X^2 \geqq 4.66) < 0.05$]. This result is taken to indicate that individuals of *P. viridis* tend to be distributed evenly within the colonies.

The pattern of dispersion suggested by this analysis probably reflects direct interaction between individuals. After a heavy settlement, the growing animals must compete for space for expansion of the lophophore during feeding. Such competition would be expected to result in an even spacing of individuals in densely populated areas. At the borders of the colonies studied, individuals appear to be less crowded together and likely to be distributed at random. These circumstances are paralleled by the case of the clam *Tellina tenuis* reported by Holme (*3*). In feeding, this small clam sweeps the surface of the substrate with its inhalant siphon. The even spacing of *Tellina* observed by Holme was found to be statistically significant by Connell (*4*). The minimum distance between individuals is thus apparently related to mode of feeding in *Tellina* and *Phoronopsis*.

Connell, using a procedure similar to that employed here, studied the spatial distribution of two species of clams, *Mya arenaria* L. and *Petricola pholadiformis* Lamarck (*4*). He found that the clams were distributed in aggregations in the area of study but at random within the aggregations. He has suggested that this is the most common pattern for sedentary, bottom, filter feeders.

The pattern of spatial distribution of sedentary marine invertebrates can have important implications in marine ecology and paleoecology. Patterns of dispersion are important clues to larval behavior, interactions of individuals, and the nonuniformity of the physical environment. Knowledge of the kinds of patterns characteristic of particular taxonomic groups or modes of life may also be useful in the interpretation of the mode of formation of fossil assemblages. In this regard, such information can aid in recognition of an assemblage that has been buried in place with a minimum of exposure after death. Patterns of spatial distributions of fossils have been determined by techniques similar to those employed here. Miller has used nearest-neighbor relations in an attempt to determine current direction in an ancient, black-shale environment (*5*). For all of these purposes, more modern analogs are needed (*6*).

Table 1. Proportion of nearest-neighbor relations that are reflexive in each of the samples.

Sample	Size	Proportion
1	99	0.53
2	114	0.59
3	171	0.58

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References and Notes

1. Locality 1 was in the small cove immediately north of White Gulch; locality 2 was on the flats east of Lawson's pier; and locality 3 was on the flats near the creek on the south shore of White Gulch (see U.S. Coast and Geodetic Survey Chart 5603, 1957).
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6. This investigation is part of studies supported by a grant from the Louis B. Block Foundation and made possible by the cooperation of the Pacific Marine Station of the College of the Pacific.

8 December 1958

Production of Spherules from Synthetic Proteinoid and Hot Water

Abstract. When hot saturated solutions of thermal copolymers containing the 18 common amino acids are allowed to cool, huge numbers of uniform, microscopic, relatively firm, and elastic spherules separate. The place of this phenomenon in a comprehensive theory of original thermal generation of primordial living units is considered.

A comprehensive theory of the spontaneous origin of life at moderately elevated temperatures from a hypohydrous magma has been developed (*1*). The theory results from experiments which have yielded linked reactions in sequences akin to many in anabolism (*1*), materials which closely resemble protein in qualitative chemical composition and physical properties studied (*2*), and a biointermediate for nucleic acid, ureidosuccinic acid (*3*).

The material with attributes of synthetic protein, *proteinoid*, is easily produced by employing sufficient excess of

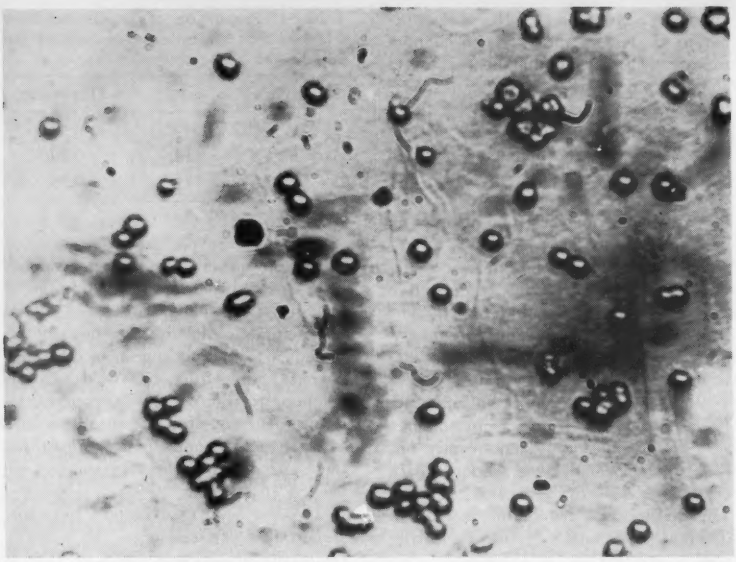

Fig. 1. Cell-like spherules prepared from 15 mg of proteinoid by 1 min of boiling with 3 ml of sea water (× 1160).

dicarboxylic amino acid in the thermal copolymerization of all of the common amino acids (*2*). Such products contain all of these same amino acids, are biuret-positive, can be salted in and subsequently salted out, reveal by end-group assay mean chain weights of 3000 to 9000, and are split by proteinases and have other properties of natural proteins.

New conceptual difficulties arise, however, when attempts are made to fit some of the conditions employed into a comprehensive theory of the origin of life. One such problem is that posed by the presumed coagulation of proteins in the first living organisms produced at elevated temperatures. The other is the general problem of understanding modulation from a primitive hypohydrous organic magma (*1*) to the predominantly aqueous entity which the first organism is assumed to have been.

Table 1. Effect of concentration of aqueous sodium chloride on diameter of spherules.

Concentration of sodium chloride solution (%)	Diameter of spherules (μ)
0.15	1.4
0.31	1.6–1.8
0.63	1.6–1.8
1.25	2.3–2.7
2.5	2.0–2.1
5.0	0.7–0.9
10	0.4–0.6
20	Almost no spherules

The problem of thermal production of a hot "native protein" is seen not to be a real one when it is recognized that thermal denaturation of protein is obviated if the water content of the system is at a value low enough to represent only tightly bound water (*4*). It is also pertinent that proteins are protected from heat coagulation by other materials, notably nucleic acids (*5*), and that regardless of conceptual difficulties some bacteria and algae thrive in hot pools (*6*).

Against this background, it may be understood that coagulation might not occur in a hypohydrous prebiological system. Denaturation, however, is indicated for the hot proteinaceous material when it is, or was, first exposed to an aqueous environment. This presumed effect was recognized as possibly being of benefit in the primordial process if prebiochemical globules containing *archeoprotein* were to be denatured at their surfaces. One could visualize by this working hypothesis the origin of cell membranes (*1*).

The scores of experiments which have been performed in testing this concept have given with proteinoid (*2*) and hot water in the proper proportions huge numbers (typically 10^6 to 10^8) of spherules of uniform microscopic size (Fig. 1). These are usually 1.5 to 3 μ in diameter, the size varying with the conditions in the particular experiment. The spherules shown in Fig. 1 were prepared from 15 mg of proteinoid (*2*) and 3.0 ml of hot sea water with 1 min of boiling, after which the preparation was allowed to cool to room temperature. The cell-like entities obtained retain their individual integrity for several weeks; if they are centrifuged at 2000 rev/min for 5 min and the supernatant liquid is removed, the spherules retain their shape and integrity.

Tendencies to aggregate, to coalesce, to lose shape, and to form spherules of different or of nonuniform size are influenced by the addition of substances to the hot water employed in the preparation. The spherules formed by adding hot water to the proteinoid (*2*) freshly formed prior to its washing by water, and ethanol, for instance, do not appear to be as tough as those prepared from washed proteinoid. The effect of one of the many added substances being studied on the size of the spherules is given in Table 1.

The entities obtained bear a relationship to cell models as previously reported (*7*) and to Oparin's coacervates (*8*). The mode of generation of the spherules from hot proteinoid and aqueous solutions in a thermal continuum, the properties of the units obtained, and the possible interpretations bearing on the origin of living cells are, however, significantly different.

The exact role, if any, of the somewhat vague concept of denaturation (*9*) in these studies is being investigated. The already abundant experiments demonstrate that the process described permits an unlimited variety of controlled variations in study of the effects on the spherules. These variations include the syntheses of proteinoid, the conditions of hydration, and the selection of the aqueous solution or suspension. The thermal homopolymer of glycine (*10*), for instance, does not form spherules. Also, shrinking or swelling can be induced by immersion of spherules in appropriate hypertonic or hypotonic solutions.

The experimental results as a whole are consistent with the total picture of thermal origins in a continuum (*1–3*). One inference derivable from these results is that spontaneous prebiological processes could have produced such enormous numbers of extensible cell-like membranes as to favor relatively the likelihood that some of these entities would also enclose enough spontaneously generated biochemical apparatus (*1, 3*) to permit replication in a sterile world (*11*).

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11. This project is supported by grant RG-4666 from the National Institutes of Health, U.S. Public Health Service, grant G-4566 from the National Science Foundation, and by the General Foods Corporation. This report is contribution No. 112 of the Oceanographic Institute, Florida State University.

24 December 1958

Learning in Rats with Extensive Neocortical Damage

Abstract. Albino rats with as much as 99 percent damage to the cerebral cortex were trained on a position habit in a simple *T*-maze. The operated rats were found to learn the problem as efficiently as normal animals even when a 30-second delay was imposed between the response and the food.

Numerous experiments have demonstrated learning in mammals that have been surgically deprived of their neocortex (*1*). When the conditioning technique is used, the results of these studies indicate that there are only slight differences in the final performance of the conditioned response in comparison to that evoked in normal animals. Few studies exist which have examined the learning ability of decorticate animals in an unrestrained, "free-moving" situation, such as traversing a single-unit *T*-maze. According to the work of Lashley (*2*), removal of as much as 80 percent of the neocortex in rats only slightly impairs the mastery of a position habit. The present study showed that rats subjected to extreme neocortical damage not only learn a position habit as readily as normal ones but are equally efficient when a delay of 30 seconds is interposed between the response and the reward.

Twenty-seven experimentally naive adult rats of the Wistar strain were used. Of these, 12 were subjected to varying amounts of cortical damage by the suction method. All operations were performed in one stage with deep ether anesthesia. From 3 to 4 weeks after surgery, all rats were trained to choose their nonpreferred position in a *T*-maze in order to obtain food. After the conclusion of the experiment the brains were removed from the operated rats, and the lesions were reconstructed on standard diagrams. Brains showing extensive subcortical damage were sectioned and stained.

The alleys of the *T*-maze were 4 in. wide and 4 in. high. The stem consisted of a start box and a choice chamber, while each arm was composed of a delay chamber and an end box. These compartments, which were separated by guillotine doors, were 12 in. long. The floor and the top of the *T* were constructed of Plexiglas, the sides of plywood. Preliminary training involved giving each rat three trials per day in the maze for four consecutive days. The first two trials were "free," while on the third trial the rat was forced to the side it had avoided on the immediately preceding trial. Each end box contained a dish of wet mash from which the rat was allowed to eat for 10 seconds. No experimental delays were interposed during this period.

Determination of the nonpreferred side for each rat was made from the data on the last 2 days of preliminary training. On day 5, each rat was trained positively to the nonpreferred side, where food was present in the end box. No food was present in the end box on the preferred side. Eight control and five operated rats were trained without any delay. That is, as the animal made a choice of the left or right arm, the guillotine door separating the delay chamber from the end box was raised, allowing the animal to enter the end box. All of the remaining rats were delayed 30 seconds in the delay chamber following a correct or incorrect choice, after which the appropriate door was raised, allowing the animal access to the end box. The noncorrection method was used. Six trials were given daily with an intertrial interval of about 3 minutes. After early daily series of trials the rat was returned to its home cage and fed for 45 minutes. Training was continued until the animal made at least 10 correct responses on two consecutive days.

To reduce the operation of differential sensory cues coming from the delay chambers, the following precautions were taken. Visual cues were eliminated by enucleating the eyes of all animals. Olfactory cues were minimized by washing the floor of the maze after each trial and by placing a dish of food mash close to the incorrect end box. Auditory cues were reduced by the background noise of an air conditioner, and tactual cues were decreased by making the left arm identical with the right arm. Thus the development of secondary reinforcement from senses other than proprioceptive-kinesthetic was minimum.

For the no-delay groups, the differences between the controls and the operated rats were far from statistically significant. The controls required a mean of 11.4 trials and a mean of 3.7 errors to reach the criterion. The means for the operated animals, on the other hand, were 12.8 trials and 3.9 errors. The average percentage of cortex damaged was 71.5. There was no relationship between lesion size and ease of learning the position habit. Table 1 presents the indi-

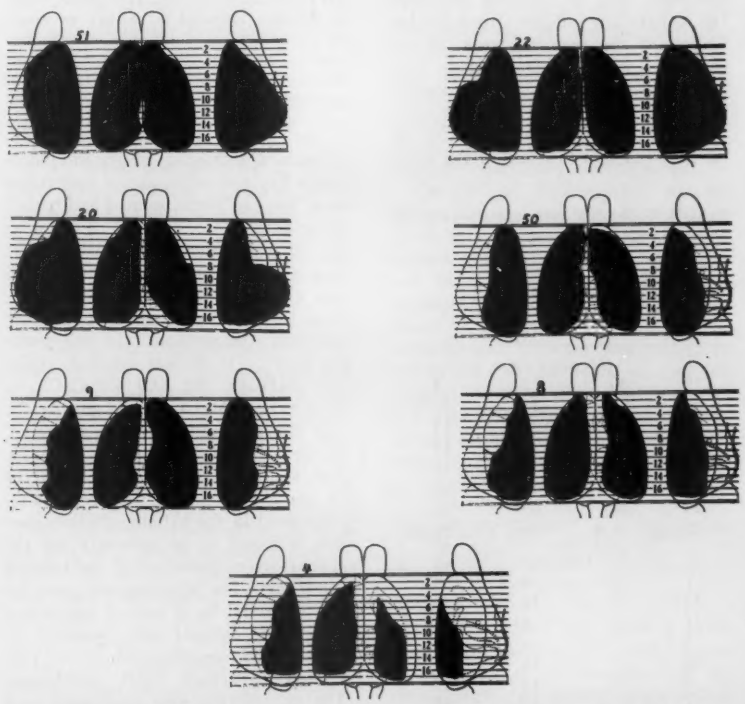

Fig. 1. Diagrams of the brains of those rats involved in the 30-second delay problem. Blackened areas indicate complete destruction of cortical surface.

vidual criterion scores for both the operated and control rats involved in the 30-second delay problem. Again, the mean differences did not approach statistical significance. Inspection of Fig. 1 reveals that two operated animals (22 and 51) were virtually decorticated. The scores of these rats were not appreciably different from those made by rats with considerably less damage or by the controls. Thus, no relationship between the size of the lesion and the ability to learn a position habit is indicated.

It is intriguing that the decorticate rats were not inferior to the controls in learning the position habit involving delayed reinforcement. The interpolation of a delay between the response and the reward is known to retard the acquisition of a position habit (*3*). In this experiment, both the cortical and control rats required more than twice as many trials to reach the criterion with a 30-second delay than they did with no delay. This reduction in learning speed is generally attributable to the decaying memory trace of the response. Apparently the neocortex is not necessary to mediate this function in the rat. The corpus striatum, septal area, hippocampus, pyriform cortex, and amygdaloid nuclei also do not appear to be specifically involved in this function, for these structures were bilaterally damaged in one or more of the operated rats of this experiment. It cannot be concluded, however, that the neocortex and its adjacent structures fail to have any influence upon the formation of the memory trace. Studies concerned with the perseverative trace (*4*), delayed response (*5*), retroactive inhibition (*6*), and multiple-unit mazes (*2*), indicate that the neocortex of the rat does function to facilitate the establishment of the memory trace. It would seem, however, that the strength of the memory trace left by a single position response is undiminished by the removal of the cerebral cortex.

Table 1. Individual criterion scores on the 30-second delay problem.

Rat No.	Cortical damage (%)	Trials	Errors
	Operated rats		
9	80	12	4
51	99	18	10
50	81	24	15
22	97	24	10
4	51	30	13
8	71	48	24
20	88	54	28
Mean	81.0	30.0	14.9
	Controls		
1		6	4
35		18	5
11		18	7
8		24	10
36		36	24
2		42	19
7		42	14
Mean		26.6	11.9

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2 January 1959

Electrophysiology of the Elasmobranch Stomach

Abstract. A consequence of the recent study of the mechanism of gastric secretion has been the presumption, implicit (*1*) if not explicit (*2*), that the distinctive gastric transmucosal potential has a fundamental role in the formation of hydrochloric acid. The following report indicates that the isolated surviving elasmobranch gastric mucosa does secrete acid but, unlike that of other vertebrates, does so without developing a significant epithelial potential difference. The gastric transmembrane potential is neither necessary for hydrogen ion secretion nor is its generation a fundamental feature of the mechanism that leads to the formation of hydrochloric acid.

The gastric mucosae from dogfish (*Squalus acanthias* L.) caught in Frenchman's Bay and subsequently maintained in a "live-car" were isolated and bathed by oxygenated saline within 10 min after the fish was removed from water. One square centimeter of mucosa separated two chambers containing saline solutions having volumes of 6 ml and the following compositions (in millimoles per liter): (i) Serosal solution; NaCl, 220; $NaHCO_3$, 30; KCl, 10; $CaCl_2$, 5; Na_2HPO_4, 1; $MgCl_2$, 2; and glucose, 25. (ii) Mucosal solution; NaCl, 250; KCl, 10; $CaCl_2$, 5; $MgCl_2$, 2; and glucose, 25. Both solutions were gassed by 95 percent O_2 and 5 percent CO_2. No urea was incorporated in the bathing solutions, nor was it found to be necessary for the satisfactory maintenance of the isolated epithelium. The transmucosal potential was measured by a pair of agar-saline bridges and calomel cells, combined resistance 0.15 megohms, which fed into a Hewlett-Packard 130B oscilloscope. The experiments were conducted at a mean ambient temperature of 22°C, which was probably supraoptimal.

In ten experiments, the mean rate of hydrogen ion secretion was 0.65 ± 0.6 (standard deviation) μeq cm^{-2} hr^{-1}. The mucosae had a wet weight of 177 ± 33 mg. The transmucosal potential difference at 40 and 160 min after isolation was -1.3 ± 1.8 and -0.9 ± 0.9 mv, considering the mucosal solution to be ground. The mean initial and final bridge junction potentials were -0.4 mv. When the solution bathing the mucosal surface was replaced by one similar to that bathing the serosal surface, the potential difference became smaller by 0.5 ± 0.2 mv. The d-c conductance was estimated from the potential change that occurred after the passage of current, 100 μa cm^{-2}, for 1 min at 40 and 160 min after isolation. The conductance was 4.1 ± 1.8 and 5.6 ± 1.7 mmho cm^{-2}. A single experiment on a skate (*Raja erinacea*) yielded similar results. The mean potential difference developed across the entire thickness of the dogfish stomach was $+0.5$ mv in two experiments, and the conductance was somewhat lower than that cited above for the mucosa when it was separated from the serosa and muscle coat. In three experiments the mucosa did not spontaneously secrete hydrogen ion, presumably because of the higher ambient temperature (26°C). The electrical characteristics were the same except for a more rapid deterioration of membrane resistance.

The isolated gastric mucosae of marine and fresh-water teleosts (*Pollachius virens, Microgadus tomcod, Myxocephalus octodecimspinosus, Pseudopleuronectes americanus, Anguilla rostrata,* and *Ameiurus nebulosis*) were studied in the same fashion except for a reduction in concentration of NaCl of the bathing solutions by 50 mmole/lit. All of these mucosae spontaneously secreted acid and developed a potential difference of more than $+15$ mv. This potential difference is similar to that developed by the isolated mucosae of amphibia (*1*), dog (*2*), and man (*3*). Microscopic slides did not disclose any striking histological difference between the elasmobranch and teleost gastric epithelia (*4*). The dogfish gastric mucosa was found to have a high content of carbonic anhydrase (*5*).

These results imply that elasmobranchs secrete H^+ without generating a significant transmucosal electrical potential difference. The absence of a potential difference cannot be attributed to a higher membrane conductance. Though the membrane conductance is somewhat larger than that of amphibia (*1*), so is the wet weight of a comparable area of mucosa. The absence of a potential is not necessarily attributable to excessive H^+ transport. At the prevailing temperature the rate of H^+ secretion was less than that of the isolated amphibian gastric mucosa. At lower temperatures the

rate of H^+ transport approached and exceeded that of the amphibian mucosa. The available evidence does not suggest that generation of an electrical potential difference is necessary for active transport of H^+ by the gastric mucosa: (i) H^+ secretion proceeds even when the potential difference is abolished or reversed by an external current (*1*, *2*); (ii) H^+ transport is less sensitive than Cl^- transport to exposure to potent inhibitors of carbonic anhydrase (*6*); (iii) substitution of SO_4^{--} for Cl^- in the bathing medium eliminates the active monovalent anion transport which is responsible for the generation of the potential difference (*7*). Nevertheless, we must inquire why, in most vertebrates secretion of H^+ is associated with a large gastric mucosal potential difference. No explanation for the mechanism of gastric secretion of hydrochloric acid will be adequate until the interdependence of Cl^- and H^+ transport is elucidated (*8*).

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22 December 1958

Free β-Hydroxy-γ-aminobutyric Acid in Brain

Abstract. By using the methods of paper chromatography and high-potential paper electrophoresis and by comparing the pattern of prepared extracts with that of synthesized β-hydroxy-γ-aminobutyric acid, we found that free β-hydroxy-γ-aminobutyric acid exists in the brains of mice, rabbits, cattle, and human beings.

γ-Aminobutyric acid (γ-ABA) has been shown to be converted to β-hydroxy-γ-aminobutyric acid (β-OH-γ-ABA) by beta oxidation and also to glutamic acid by transamination between β-OH-γ-ABA and α-ketoglutaric acid (*1*). On the other hand, hydroxyproline may be converted, in vitro, to β-OH-γ ABA via Δ^1-pyrroline-4-hydroxy-2-carboxylic acid (*2*). Formation of β-OH-γ-ABA through decarboxylation of allo-β-hydroxyglutamic acid has also been shown with an enzyme sample obtained from various strains of *Escherichia coli* (*3*).

β-Hydroxy-γ-aminobutyric acid inhibits nervous transmission in a manner similar to Florey's fraction I (*4*), and also antagonizes the convulsions induced by the injection of sodium glutamate, sodium citrate, sodium phosphate, sodium chloride, and acetylcholine into the motor area of the cerebral cortex. It also antagonizes the convulsion induced by electric stimulation (*5*).

Immediately after fresh brain material was obtained, a homogenate was made and kept frozen until deproteinization by 70 percent ethanol. The deproteinized liquid was subjected to petroleum ether extraction to remove lipids and was evaporated to dryness at 45°C in a vacuum. The residue was dissolved in a small amount of distilled water and applied on Toyo-Roshi No. 131 filter paper for high-potential paper electrophoresis and paper chromatography.

Comparative high-potential paper electrophoresis of the brain extract and of a synthesized sample (*6*) of β-OH-γ-ABA was made. The extract and the synthesized sample were applied in juxtaposition on the starting line of the filter paper and gave the pattern shown in Fig. 1. Juncture, in such a pattern, of the area of a synthesized sample with the area of a certain constituent of an extract of biological materials has always been demonstrated when the two are identical; we may, therefore, tentatively identify the constitutent represented by the zone which is in juncture with the zone of the synthesized sample as β-OH-γ-ABA. Similar results were obtained with the brains of mice, cattle, rabbits, human beings, and also with the blood of rabbits and of human beings.

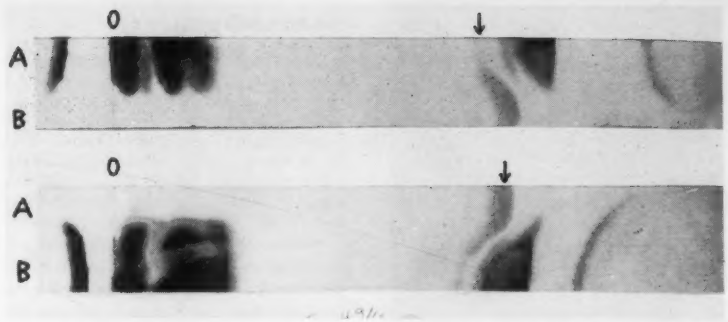
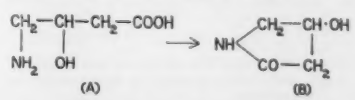


Fig. 1. Comparative electrophoresis of cattle brain (top) and human brain (bottom). *O*, starting line; *A*, prepared extract; *B*, synthesized sample; arrow, the juncture of the area of synthesized sample with the area of prepared extract. Condition of electrophoresis, 100 v/cm, 25 ma, 40 min; electrolyte, pyridine-acetic acid-water (1:10:89), *p*H 3.6; filter paper, Toyo-Roshi No. 131, 20 by 2 in.; stain, acetone solution of 0.5 percent ninhydrin.

The zone thus tentatively identified as β-OH-γ-ABA was cut from the paper and subjected to water elution. The eluate was applied on Toyo-Roshi No. 131 filter paper for one-dimensional paper chromatography. *n*-Butanol-acetic acid-water (4:1:1) was used as solvent. The R_f value of the constituent in the eluate coincided perfectly with that of the synthesized β-OH-γ-ABA at 0.38 (Fig. 2).

For further identification, a small amount (0.2 mg) of purified crystalline sample of R_f identical with that of the synthesized sample was obtained from the homogenate of 1.6 kg of cattle brain after deproteinization, removal of the lipids, and treatment with charcoal and ion-exchange resin and fractionation by means of paper chromatography and high-potential paper electrophoresis.

The yield of "β-OH-γ-ABA" thus obtained, however, was all too small compared with the original "β-OH-γ-ABA" content of the starting material, which was estimated by colorimetry—for example, 48.6 mg of β-OH-γ-ABA was found in 100 g of wet temporal lobe of cattle (*7*). This was assumed to be due to the fact that there are four isomers of β-OH-γ-ABA: *l*-β-OH-γ-ABA and *d*-β-OH-γ-ABA, both in chain and cycloid forms; the chain form may be easily converted to the clycloid form, particularly in an alkaline medium (*8*).



The chain form (*A*) gives a violet color with Ninhydrin and a yellow color with KIO_4-Nessler's reagent, and the cycloid form (*B*) gives a bright yellow color with Ninhydrin and remains colorless with KIO_4-Nessler's reagent on the filter paper.

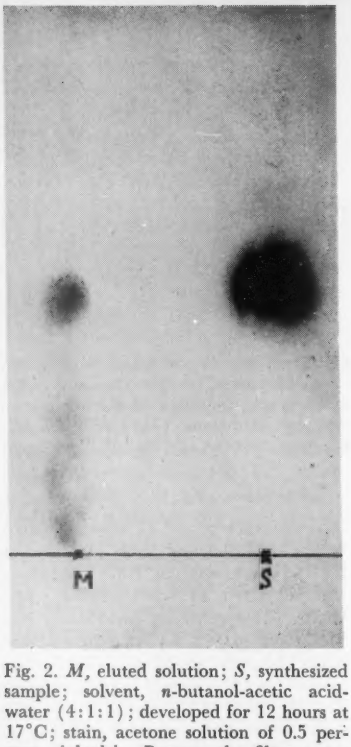


Fig. 2. *M*, eluted solution; *S*, synthesized sample; solvent, *n*-butanol-acetic acid-water (4:1:1); developed for 12 hours at 17°C; stain, acetone solution of 0.5 percent ninhydrin. Because the filter paper was too large for our photocopying instrument, the upper part of the paper had to be omitted from the photographic reproduction.

The synthesized sample, when it was developed by means of paper chromatography and high-potential paper electrophoresis, gave a second area of faint color (Fig. 1). The area showed the above-stated characteristic reactions of the cycloid form.

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Blood-Brain Barrier for Adrenaline

Abstract. The concentration of tritium-labeled adrenaline was determined in various areas of cat brain after intravenous infusion. It did not exceed that expected from the blood content of the tissue except in the hypothalamus, where small but significant amounts of H^3-adrenaline were found.

Since adrenaline, after peripheral administration, produces mental and central-neurophysiological effects, it has been assumed that it acts directly on the central nervous system. However, there is no experimental evidence whether or to what extent it crosses the blood-brain barrier.

The availability of tritium-labeled adrenaline of high specific activity (*dl*-β-H^3-adrenaline bitartrate, 1 mg = 267 μc) made it possible to study the passage of adrenaline from blood to various regions of cat brain. Tritium-labeled adrenaline was infused into the femoral vein of cats anesthetized with Nembutal at rates varying in different experiments from 2.7 to 20.7 μg/kg per minute over a period of 30 minutes. Immediately before the animal was killed by decapitation, blood samples were withdrawn from the femoral artery, heparin being used as an anticoagulant. Samples of brain and other tissues were homogenized in 9 volumes of 0.1*N* HCl. The extracts, after the addition of 0.1 volume of 1 percent (wt./vol.) disodium ethylenediaminetetraacetate and 0.05 volume of 2 percent (wt./vol.) ascorbic acid, were adjusted to *p*H 8.4, centrifuged, and passed over columns of aluminum oxide (*1*). After washing and eluting (*1*), the eluate was evaporated in a vacuum and taken up in methanol, and a portion was added to a mixture of 3 ml of ethanol and 10 ml of 0.4 percent (wt./vol.) 2,5-diphenyloxazole and 0.01 percent (wt./vol.) β-bis [2-(phenyloxazolyl)] benzene in toluene for counting in a liquid scintillation spectrometer. Plasma was diluted with 1 volume of 0.2*M* sodium acetate and, after *p*H adjustment, was similarly passed over aluminum oxide and processed. Recoveries of added H^3-adrenaline were about 80 percent.

The specificity of the procedure was tested by paper chromatography: extracts of plasma and tissues were treated as described, and the resulting methanol solutions were applied to Whatman No. 1 paper and run in butanol:acetic acid:water (*2*) or in phenol:water:SO_2 (*3*). Scanning of the chromatograms revealed only a single peak of radioactivity having the same R_F-value as adrenaline.

Since brain contains on the average 0.024 ml of blood per gram (*4*), some radioactivity, amounting to about 2 percent of that of plasma, is contributed by the blood content of the tissue. Table 1 shows that the H^3-adrenaline of brain significantly exceeds 2 percent of the radioactivity of plasma in only one area, the hypothalamus, indicating that this is the only area where transfer occurs (*5a*).

This particular property of the hypothalamus is of special interest in view of the localization of sympathetic centers and the high concentration of noradrenaline (*5*) in this region. It should be noted, however, that the quantities of adrenaline transferred are relatively small. Even at the highest rate of infusion, which was probably twice as high as the maximum rate of adrenaline secretion (*6*), the concentration of H^3-adrenaline in the hypothalamus did not exceed 0.025 μg/g. Correspondingly smaller amounts were taken up at lower rates of infusion. It is known that the periventricular gray substance which is located in the region of the hypothalamus bordering the third ventricle and backward along the cerebral aqueduct is more accessible to vital stains circulating in the blood than the rest of the brain (*7*). We cannot say at present whether the increased permeability to circulating adrenaline is related to these elements.

In marked contrast to brain, large concentrations of H^3-adrenaline were found in all other tissues examined; those in heart, spleen, and pituitary and adrenal glands exceed the concentration in plasma several fold (*8*).

Negligible amounts of radioactive metanephrine (3-O-methyladrenaline), the principal metabolite of adrenaline (*9*), were found in brain though, like H^3-adrenaline, it was present in large amounts in plasma and in other tissues. This suggests that the failure to find significant quantities of H^3-adrenaline in brain was not the result of an unusually rapid metabolism.

It may be concluded from these experiments that adrenaline is unable to cross the blood-brain barrier except to a small extent in the hypothalamus. Any central effects of adrenaline after peripheral administration may therefore be the result of its interaction with hypo-

Table 1. Transfer of H^3-adrenaline into various areas of cat brain.

Area	Brain/plasma ratio*
Medulla oblongata	0.049 ± 0.0209
Cerebellum	0.029 ± 0.0093
Pons	0.023 ± 0.0054
Hypothalamus	0.106 ± 0.0177
Midbrain	0.027 ± 0.0074
Thalamus and corpus striatum	0.025 ± 0.0122
Cerebral cortex	0.017 ± 0.0070
Cerebrospinal fluid†	0.005

* Means of five experiments ± standard error.
† Single experiment.

thalamic or peripheral receptors. Moreover, since adrenaline is present and, presumably, is metabolized in the brain, it must be formed there from precursors which cross the blood-brain barrier (*10*).

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10 December 1958

Preliminary Identification of Crystalline Phases in a Transparent Stalactite

Abstract. Of two crystalline phases found in a cavern stalactite, the major phase is mirabilite, whereas the minor phase, according to preliminary data, is a new mineral, sodium hemicalcium sulfate dihydrate, which is unstable at temperatures above 25°C.

In 1955 W. T. Austin and J. J. Lehrberger explored and documented photographically a series of new passages in the Flint Ridge Cavern system of south-central Kentucky. A number of spectacular, glasslike stalactites were found in one of the passages. When specimens collected from these deposits were taken above ground, they effloresced and melted. Hence, to obtain material for the study described in this report, two samples were transported to the laboratory under a cool atmosphere saturated with water vapor.

Both samples consisted chiefly of a transparent material that occurs in short prismatic crystals showing a vitreous luster and a conchoidal fracture. About 1 percent of each sample was made up of a second substance somewhat less transparent and occurring in monoclinic needles.

The major phase was extracted from the mineral sample with ice water. After the insoluble minor phase had been removed by filtering, the filtrate was found to contain only Na^+ and SO_4^{--} ions accompanied by traces of Ca, Si, Mg, and Al; these elements were detected with a spectroscope. The observed melting point of the major phase was 33° to 34°C (sealed capillary). Accordingly, the water-soluble phase present in the stalactite is unquestionably mirabilite ($Na_2SO_4 \cdot 10H_2O$), which melts at 32.4°C; This finding was confirmed by measurements of the index of refraction and specific gravity. The observed value for the refractive index was 1.40 [literature value, 1.36 (*1*)], and the observed value for the specific gravity was 1.46 [literature value, 1.48 (*1*)].

A sample of the minor phase suitable for analysis was obtained by grinding the gross specimen to a fine powder, extracting the soluble major phase with an ice-cold alcohol-water mixture, and finally collecting the insoluble solid on a weighed, sintered glass filter. The weight of the minor phase indicated that it was originally present in the stalactite to the extent of about 1 percent. The weight loss obtained by heating the insoluble fraction to constant weight at 125°C (in a vacuum) indicated that the minor phase contains between 7.9 and 8.0 percent bound water. The anhydrous salt was found to be somewhat soluble in water and was readily soluble in dilute hydrochloric acid. The acid solution was found to contain only Ca^{++}, Na^+, and SO_4^{--} ions along with traces of Al, Mg, and Si (detected by spectroscope).

Two naturally occurring double sulfates of sodium and calcium are recorded in the mineralogical literature: These are glauberite ($Na_2SO_4 \cdot CaSO_4$) and ciempozeulite ($3Na_2SO_4 \cdot CaSO_4$), both of which are anhydrous salts. Therefore, a quantitative measurement of the Na : Ca ratio was necessary to ascertain whether the minor phase was a hydrated modification of those double salts or another mineral. A conventional determination of both elements gave a Na : Ca ratio of 3.821, which is not in agreement with the Na : Ca ratio of either glauberite (theoretically Na : Ca = 2.00) or ciempozeulite (theoretically, Na : Ca = 6.00).

Hill and Wills (*2*) have made a study of the ternary system $CaSO_4$-Na_2SO_4-H_2O at 25°, 35°, 50°, and 75°C. They obtained a labile sodium hemicalcium sulfate ($2Na_2SO_4 \cdot CaSO_4 \cdot 2H_2O$) from the action of gypsum on an aqueous solution of sodium sulfate. Upon standing, the solution becomes filled with long, slender needles which are so closely knitted together that as little as 1 percent of the labile salt will hold the mass in suspension, so that no movement occurs when the reaction vessel is inverted. The calculated Na : Ca ratio for Hill and Wills' metastable salt is 4.00, which is in fairly good agreement with the value of 3.821 obtained for the minor phase of the stalactite. The measured refractive index of the minor phase is 1.518, which compares favorably with the value of 1.510 observed by Hill and Wills for their metastable salt.

On the basis of the observed Na : Ca ratio, water of hydration, refractive index, and the weight ratio between the major and minor phases, it is tentatively suggested that the minor phase is identical with the sodium hemicalcium sulfate dihydrate described by Hill and Wills. The somewhat low Na : Ca ratio and the slightly high refractive index can best be explained by the probable presence of a very slight excess of calcium sulfate in the mineral specimen taken for this preliminary study.

The labile salt described is metastable with glauberite within the temperature range of 25° to 75°C (*2*) and is, therefore, stable at the cavern temperature (12° to 15°C). At temperatures above 25°C, the reaction

$$2Na_2SO_4 \cdot CaSO_4 \cdot 2H_2O \rightarrow CaSO_4 \cdot Na_2SO_4 + Na_2SO_4 + 2H_2O$$

would account for the conversion of the minor phase to an equilibrium mixture of glauberite and thenardite (*3*).

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12 March 1959

Occurrence and Morphology of a Phenotypic Male of a Gynogenetic Fish

Abstract. A phenotypic male of *Mollienesia formosa*, a gynogenetic fish, has been collected at Brownsville, Texas. The male and female fish are essentially similar, and their morphology supports a hypothesis that the species is of hybrid origin.

Many workers have demonstrated the occurrence of gynogenesis—activation of unfertilized eggs by sperms with the removal of paternal chromatin during early cleavage of the resulting offspring (*1*).

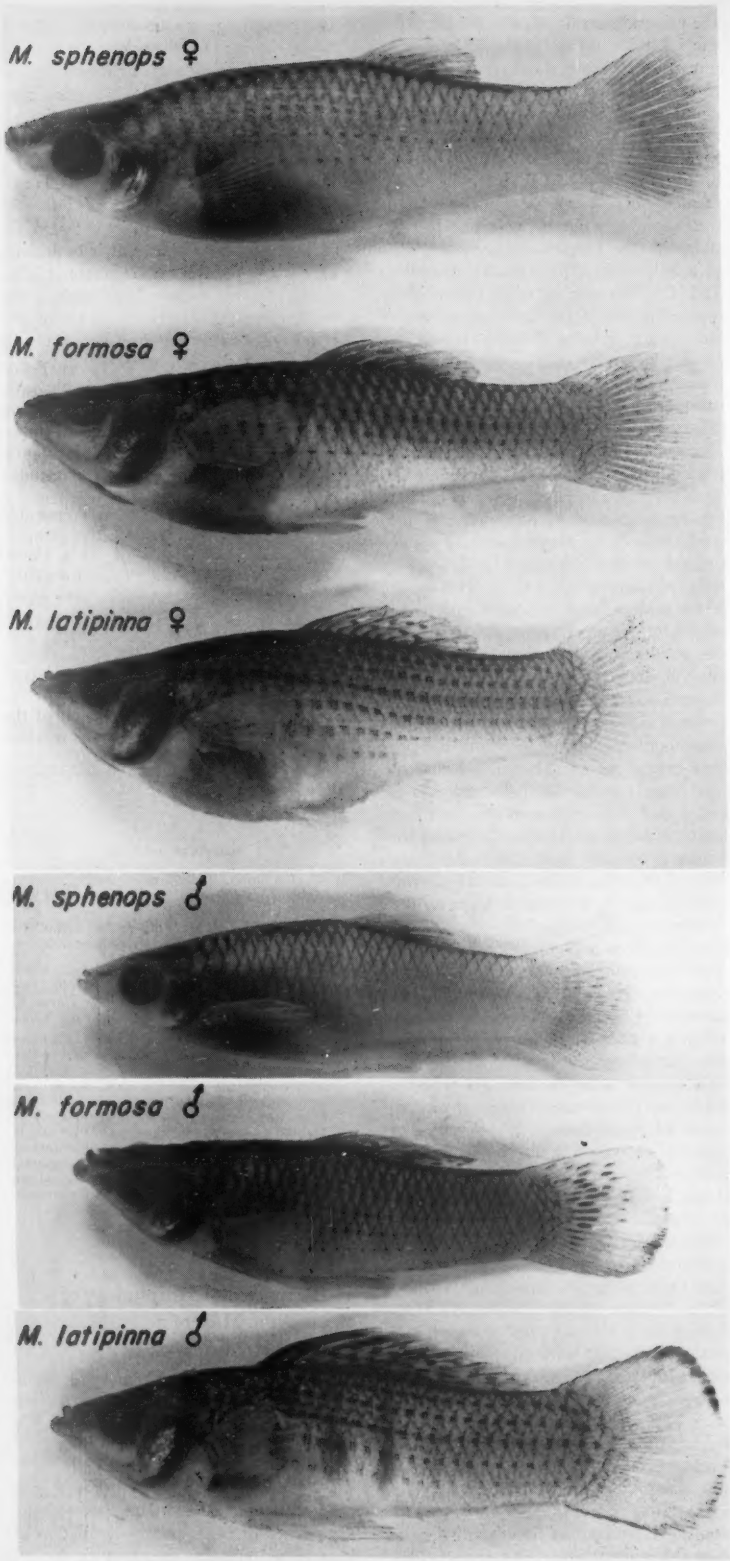

Fig. 1. Individuals of both sexes of *M. sphenops*, *M. formosa*, and *M. latipinna*, showing comparative body forms and color patterns.

Only a small fraction of the examples concerns species in which gynogenesis is the normal mode of reproduction. The sole known example in vertebrates is *Mollienesia formosa* (Girard) (*2–4*), a fish living in northeastern Mexico and southern Texas. Meyer (*5*) considered that the nucleus of *M. formosa* includes male chromosomes which are totally inactive and are eliminated during the following meiosis. This difference of interpretation regarding details of the mode of inheritance has not been resolved; however, the morphologic presence but functional absence of paternal chromatin differs little from the mechanism of gynogenesis. Females of *M. formosa* produce broods after they are placed with mature males of many related species, but virgin females never do (*2, 3, 5*). None of these broods include males, and all offspring are replicates of their mothers (*6*). In nature the *M. formosa* females uniquely make use of related species, *M. latipinna* LeSueur and *M. sphenops* (Cuvier and Valenciennes), utilizing sperm from these males to stimulate development.

On 14 August 1958, we and others from the University of Texas Institute of Marine Science, with the aid of a local Baptist Sunday-school class, sampled *Mollienesia* in the vicinity of Brownsville, Texas. These collections were examined in the laboratory, and one was found to contain a phenotypic male of *M. formosa*. The pertinent collection was obtained from a drainage ditch ½ mi west of Brownsville International Airport. This collection included 1108 females of *M. formosa* as well as 30 females and 11 males of *M. latipinna*. The obviously one-sided sex ratio of *M. formosa* is in agreement with the previous work on this species. The sex ratio of *M. latipinna* probably results from high male mortality typical of these and related fishes (*7*).

There is little doubt that this phenotypic male fish is either an F_1 hybrid between *M. sphenops* and *M. latipinna* or a male of a previously all-female gynogenetic species. As laboratory-produced F_1 hybrids and masculinized females cannot be distinguished morphologically (*8*), it is not possible to ascertain without doubt which of the alternative possibilities is correct. We tend to discount the possibility that the fish is an F_1 hybrid. *Mollienesia sphenops*, one of the suggested parent species, is not known to occur in the vicinity of Brownsville. The nearest localities where it has been found are China; Nuevo León, Mexico (more than 150 miles from the collection locality); and the Río San Fernando (separated from the collection locality by the open ocean). As related fishes are known to remain within limited areas during their entire life span (*9*), it is not likely that this male or one of its

Table 1. Characteristics of three species of *Mollienesia*. Averages are given, with the range in parentheses.

Sex	*M. sphenops*	*M. formosa*	*M. latipinna*
	No. of dorsal rays		
F	9.0 (9)	11.2 (10–12)	13.4 (13–14)
M	9.0 (9)	11	13.4 (13–14)
	No. of scale rows between dorsal and occiput		
F	12.0 (12)	10.5 (10–11)	8.6 (8–9)
M	11.5 (11–12)	9	7.1 (6–8)
	No. of pectoral rays		
F	15.1 (14–16)	14.6 (14–15)	13.2 (13–14)
M	15.0 (14–16)	14.0 (14)	13.1 (12–14)
	Ratio of predorsal length to length of dorsal base		
F	4.69 (4.5–5.0)	2.73 (2.6–2.9)	1.88 (1.8–2.1)
M	3.84 (3.3–4.1)	2.34	1.36 (1.2–1.7)

parents wandered many miles during its life span. We also doubt that one of its parents was released by a tropical-fish hobbyist. If this fish is an F_1 hybrid, it is the sole known natural hybrid of a combination thought to have resulted in the formation of *M. formosa*.

The male was compared with 10 females of *M. formosa* and with 10 of each sex of *M. latipinna* from the same collection. It was also compared with six males and 10 females of *M. sphenops* from the Río Pánuco system in Vera Cruz, Mexico. It resembles the females of *M. formosa* in traits not normally sexually dimorphic in *Mollienesia* (see Table 1, number of dorsal rays and pectoral rays) and differs from the females just as males of the other species differ from the females (see Table 1, scale rows between dorsal origin and occiput and ratio of predorsal length to length of base of dorsal fin).

The male also resembles females of *M. formosa* in color pattern (Fig. 1). Both male and female have lateral spotting intermediate between that of the spotted *M. latipinna* and the almost plain *M. sphenops*. Both have the caudal base mottled, in contrast to the clear caudal base of *M. latipinna* and the dusky base of *M. sphenops*. The dark caudal margin of the male is weak, whereas in the male of *M. latipinna* the dark margin is well developed and in males of *M. sphenops* the caudal margin is clear.

In body shape the male is intermediate between the robust *M. latipinna* males and the slenderer males of *M. sphenops*. Similarly the gonopodial structures of the male are intermediate between those of *M. latipinna* and those of *M. sphenops*. The serrae on ray 4p extend two segments beyond the tip of the spines on ray 3 in males of *M. latipinna*, one segment beyond in the male *M. formosa*, and to the tip of the spines on ray 3 in males of *M. sphenops* (*10*). The spines of the gonopodia in *M. latipinna* are equal in length to the basal elements and are strongly curved toward the fin base; in *M. formosa* they are slightly longer than the basal elements and are gently curved, and in *M. sphenops* they are much longer than the basal elements and are very nearly straight. The consistently intermediate position of the *M. formosa* male supports a hypothesis that the species originated as a hybrid between *M. sphenops* and *M. latipinna* (*2*, *4*). The *M. formosa* male is extreme with respect to the suspected parental forms only in having the largest gonopodial hood. Such extremes do occasionally occur in known hybrids (*11*). Its morphology bears the same position relative to that of the suspected parental forms as does the morphology of other natural fish hybrids relative to that of their suspected parental forms (*4*).

The effect of rare natural males on wild populations of *M. formosa* as well as the mechanism by which these fish developed male reproductive organs is an interesting field of study. Unfortunately this male was preserved in the field (because of the large sample and the knee-deep mud at the sampling station). It was therefore impossible to ascertain the effects of its chromatin in crosses with females of its own species and with females of related species. Microscopic examination of the gonad shows the milky white smooth texture typical of testes of related species, without any of the yellow tinge or granular texture typical of females. As the gonopodium is somewhat opaque at the tip, the male is believed to have been nearing maturity.

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6. Among the many experimental broods about which data are as yet unpublished are a few which are bisexual and intermediate between the parental phenotypes. Efforts to repeat these results are now under way; however, none of these broods include males of the *M. formosa* phenotype. (C. P. Haskins, personal communication, 1958.)
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11. C. Hubbs and K. Strawn, *Evolution* **11**, 1 (1957).

13 November 1958

An Approach to Quantifying Various Types of Spontaneous Activity

Abstract. The output of an activity-measuring device is fed into low- and high-gain cumulative recorder channels which are reset to zero after different time periods. The records, inscribed at various paper speeds, are easily quantified. The tracing patterns can be identified with specific activities of undisturbed animals. The activities are monitored by means of closed-circuit television.

The quantity and quality of spontaneous behavior, simultaneously measured, should be sensitive indicators of the effects of physiological, psychological, and pharmacological procedures. Unfortunately, the techniques generally used to ascertain the random activity of animals yield either a single number or a kymographic record of the pattern of activity (*1*) which is difficult to quantify. A start toward solution of the problem of obtaining precise information on both parameters simultaneously has been made by combining a specially designed cumulative recorder that indicates the interruption of a light beam across the animal's cage (*2*) with closed-circuit television.

The recorder, a modification of Skinner's design (*3*), has several distinctive features. (i) The same input feeds simultaneously into a low-gain channel and into a channel with a gain which is 10 to 50 times that of the other. To obtain the records shown in Fig. 1, the low-gain channel was set at 500 light-beam interruptions, full scale, and the high-gain channel at 50 interruptions, full scale. (ii) Reset to zero is based on elapsed time rather than on accumulated number; the low-gain channel is reset every 15 minutes and the high-gain channel, every 0.5 minute. As a result of this feature, the height of the line gives a num-

ber per unit of time without further calculation. Connecting the tops of the lines gives a curve representing the first derivative, rate of change. (iii) A variable-speed paper drive is used so that measurement of the interresponse interval may be as fine as is needed for various purposes. The paper speed used for the charts shown in Fig. 1 was 0.25 mm per second.

As may be seen in Fig. 1, certain rates or slopes of line recur on records for specific animals. Through the use of closed-circuit television, operated simultaneously with the cumulative recorder, particular types of behavior have been identified with particular rates or slopes of line (especially on the high-gain channel). Observation by television, of course, has the advantage that the animal's environment is not disturbed. Once the records and behavior of an animal have been correlated, television need be used only periodically, since a considerable portion of the total activity can then be *qualitatively* identified from the slope of the line. Moreover, this behavior can be easily and accurately *quantified* on the basis of the absolute height of the line.

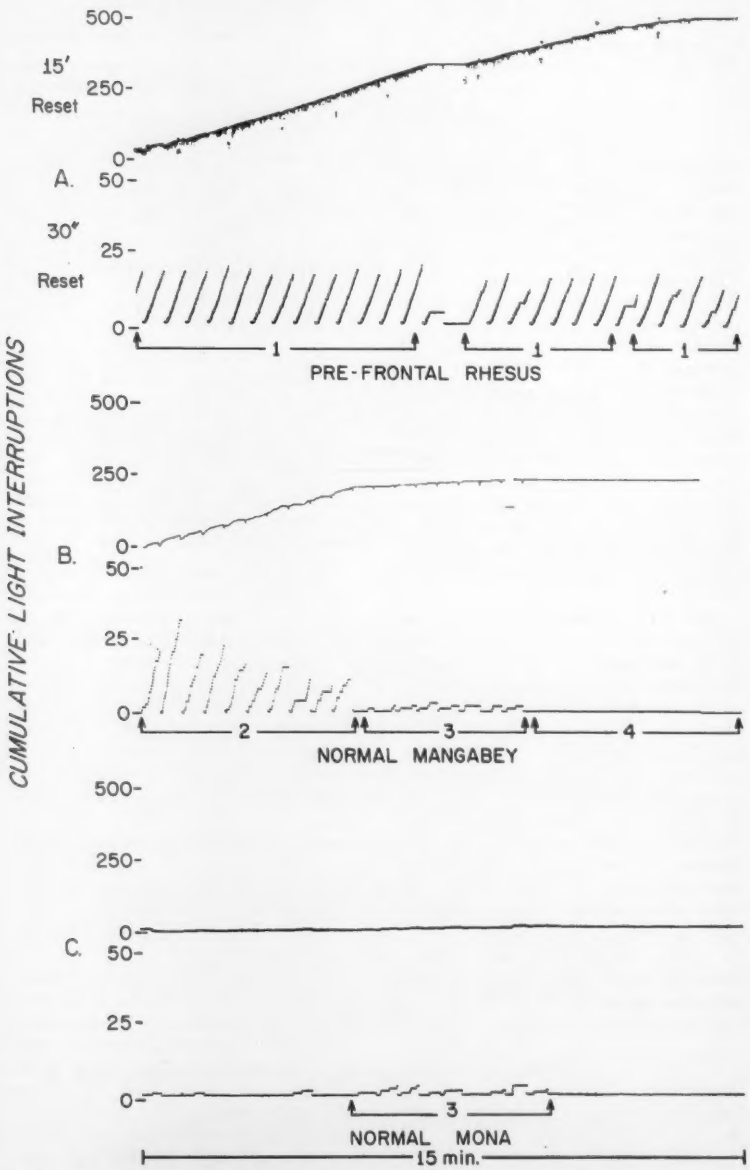

Fig. 1. Rates and patterns of activity of three monkeys as recorded on the low-gain (15-minute reset) and the high-gain (30-second reset) channel. The numbers below the tracings refer to patterns of activity. *1*, Unidirectional circular pacing typical of rhesus monkeys subjected to prefrontal lobotomy; *2*, very rhythmic leaping-pacing behavior typical of mangabeys; *3*, random changes of position in the cage; *4*, either sitting at rear of cage doing nothing or lying on back on the floor of the cage. The downward deflections on the low-gain channel result from the noise of the recorder.

Figure 1*A* is the record for a monkey (*Macaca mulatta*) which was hyperactive after a prefrontal lobectomy (*4*). This animal's activity consisted almost entirely of circular pacing, and the uniformity in the amount of this activity in successive half-minute periods is very striking. Figure 1*B* is a record for a normal mangabey (*Cercocebus torquatus atys*) that was engaging in a certain amount of rhythmic behavior, reflected in a characteristic slope, and then in nonspecific cage ramblings, which also produced a characteristic pattern. The terminal portion of the record indicates a period of inactivity. Figure 1*C* illustrates the pattern of activity of a monkey (*Cercopithecus mona*) not indulging in any rhythmic or recurrent action at all—an animal that is, in fact, exceptionally inactive.

Obviously, the records most easily analyzed are those from animals showing some rhythmic or cyclic activity, since such activity can be identified with great confidence. Even the more heterogeneous tracings without constant slopes can, however, be associated with at least a general category of behavior, which may be peculiar to an individual animal. To what extent a particular slope of line may be used to specify a type of behavior for any animal rather than for a particular animal has not yet been determined. At present the technique is being used only for analysis of the behavior of individuals, both normal animals and those with surgically produced neural lesions.

When, as in the experiments currently being conducted, interruption of a beam of light is used as a means of determining activity, only actions involving gross motor movements are measured. Perhaps use of a cage with a suspended floor which is easily disturbed (that is, a very sensitive jiggle cage) would make it possible to record and identify small-amplitude movements such as scratching. It is estimated that records obtained with the apparatus described in this report (*5*) account for roughly 80 to 90 percent of the total energy expended by an animal in somatic muscle activity.

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4. This study was aided by a contract (N113-150) between the Office of Naval Research, Department of the Navy, and the University of Washington.
5. We are indebted to Edmund H. Brand for the design of most of the equipment utilized in the study and to Dennis Meadows for the construction and maintenance of the equipment.

28 November 1958

Factors Involved in the Effect of Serotonin on Evoked Electrocortical Potentials

Serotonin, when it is injected into the common carotid artery, causes a transitory inhibition of the (ipsilateral) transcallosal response (Marrazzi *et al., 1, 2*). Marrazzi *et al.* conclude that serotonin inhibits the ipsilateral cortical synapses. However, the question arises whether serotonin may not exert its inhibiting effect upon the cortical synapses indirectly—that is, via subcortical or even extracerebral receptors such as the carotid sinus receptors. Bonvallet *et al.* (*3*) have demonstrated that an increase in excitation in the pressoreceptors leads to an inhibitory picture in the electroencephalogram, and Heymans *et al.* (*4*) have shown that serotonin has an excitatory effect upon the pressoreceptors in the sinus.

In cats anesthetized with dial-urethane (0.45 ml/kg), the right carotid sinus was denervated. Fine metal canulae were inserted into the common carotid artery on both sides, approximately 1 inch below the carotid sinus. Optically evoked potentials were recorded in the conventional manner from both visual areas. A short light flash was applied every 6.3 seconds. The standard procedure was to give ten control stimuli and then to inject the serotonin and to record another 50 responses. Injections into the innervated (left, *I*) artery and into the denervated (right, *D*) artery were alternated at intervals of not less than 30 minutes. Each injection yielded two sets of records, an ipsilateral (with respect to site of injection, *I*) one and a contralateral one (*C*). Thus four sets of records were available from each pair of injections, referred to as *II*, (innervated, ipsilateral), *IC* (innervated, contralateral); *DI* (denervated, ipsilateral); and *DC* (denervated, contralateral). We averaged the results in each of these four groups after we had converted the measured values to ratios with respect to unity, and we calculated the area between the curve connecting the (averaged) peaks of the responses and the straight line representing the mean of the (preinjection) control values for the four experimental situations. Areas below the control were designated as "minus," indicating inhibition, those above as "plus," indicating facilitation. Our results are based on 27 experiments with 1.25, 5.0, and 10.0 μg of serotonin per animal.

As is shown in Fig. 1, denervation of the carotid sinus does not abolish the effect of intracarotid injection of serotonin. However, quantitative differences between *II* and *DI* indicate that part of the cortical effect is induced from the carotid sinus and conveyed to the cortex via nervous pathways. Since effects are obtained from the denervated carotid on the ipsilateral (*DI*), as well as on the contralateral cortex (*DC*), the drug evidently excites receptor sites which have a bilateral modulating effect upon the optic cortex (*5*). Such receptors are in all probability located in the reticular core. Finally, differences between the ispi- and contralateral records point toward participation of a cortical receptor site sensitive to serotonin. From this evidence we conclude that the following three factors play a part in bringing about the cortical effect: (x) a nervous influence induced by stimulation of carotid sinus receptors, conveyed from there to the brain stem and from there via ascending unspecific diffuse systems to the ipsilateral and the contralateral cortex (*5*); (y) a bilateral nervous influence via ascending unspecific systems, activated by the drug at receptor elements located in the brain stem; (z) a direct influence of the drug in question on the cortical (*5*) synapses on the side of the injection. We further assume that the effects of these components add algebraically to bring about the cortical effect. The following equations indicate the way in which these factors are combined in the four experimental situations:

$$II : x + y + z \quad (1)$$

$$IC : x + y \quad (2)$$

$$DI : y + z \quad (3)$$

$$DC : y \quad (4)$$

$$\therefore \quad IC + DI - DC = II \quad (5)$$

The values obtained indicate that Eq. 5 is well satisfied by our experiments, although there is a residue of positive or negative sign. On the basis of Eqs. 2, 3, and 4, the time course of factors x, y, and z as $f(t)$ was calculated from the values of *IC*, *DI*, and *DC* at any time t. Figure 1 shows the result in smoothed average curves (ten values each). Furthermore, Fig. 1 shows that the curve $\Sigma\,(xyz)_t$ follows closely curve II_t. This is another indication that our assumptions and equations are valid.

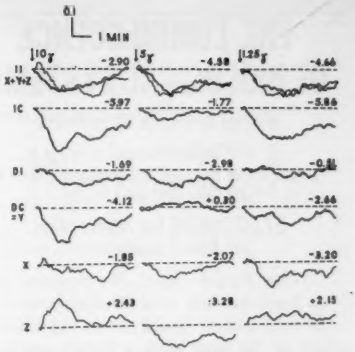

Fig. 1. Effect of serotonin (10, 5 and 1.25 μg) on optic potentials. The numbers at the top of each curve indicate the areas between preinjection values (dashed horizontal lines) and the peak-to-peak distance of the primary positive and negative response (solid lines). The abbreviations *II, IC, DI,* and *DC* indicate the different experimental situations described in the text; x, y, and z are the factors calculated on the basis of Eqs. 2, 3, and 4. All curves are smoothed averages (10 values) from mean values of 10 (10 μg), 9 (5 μg), and 8 (1.25 μg) experiments. The heavy line in the top section is II_t; the thin line is $(x+y+z)\ t$. Note the good coincidence. Abscissa: time; ordinate: one-tenth relative amplitude.

The method described here thus allows one to "fractionate" drug effects and to gain insight into the intimate mechanisms involved in the action of "centrally active" chemicals.

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6. This work was aided by grants from the U.S. Public Health Service (MY-2211), the Ford Foundation, and the Scottish Rite Fund for Dementia Praecox Research through the National Association for Mental Health.

10 December 1958

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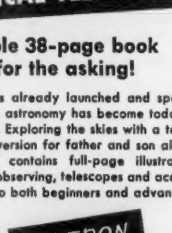

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Meetings

Wildlife Management Institute

The Wildlife Management Institute, a recent affiliate of the American Association for the Advancement of Science, was established in 1946, but its program has been continuous since 1911, when the American Game Protective and Propagation Association was established to promote better game laws and wildlife restoration through the artificial propagation of game. As new concepts developed, that program was expanded and amplified, and succeeding reorganizations became necessary in order to broaden the scope and magnitude of the work.

Since 1946, the institute's program has embraced all phases of conservation, improved management, and proper utilization of natural resources and has included the fostering of research and field investigations through the issuance of a limited number of graduate fellowships and grants-in-aid each year for specialized work in the natural sciences.

The institute sponsors and conducts the annual North American Wildlife Conference, the largest conservation meeting of its kind in the Western Hemisphere, which is attended by representatives from practically every major conservation organization, from many scientific societies and educational institutions, and from most of the state, provincial, federal, and dominion natural-resource agencies in the United States, Canada, and Mexico. These yearly conferences, if one includes the American Game Conferences—the name by which they were originally known—date back to 1915. The general and technical sessions are open to the public without a registration fee, and the published *Transactions,* which are made available at cost, are used widely as reference books in many colleges and universities and by scientific workers in the fields of biology, ecology, soil and water conservation, wildlife management, and forestry.

The institute also publishes carefully selected authoritative books on wildlife, principally monographs on birds and mammals, that have been written by leading authorities in those fields. These are priced as low as possible consistent with high standards of literary quality.

The institute maintains a staff of highly trained field representatives which works closely with the various governmental conservation agencies and private organizations at state, regional, and federal levels. Aside from their staff assignments, all of these technicians conduct important research on major biological problems in their respective territories. Two Canadian wildlife research stations, also staffed with biologists of the highest caliber, are operated by the institute—the Delta Waterfowl Research Station in Manitoba and the Northeastern Wildlife Station at the University of New Brunswick in Fredericton. Independent research is performed by the permanent staffs of these stations, and, in addition, they serve as outdoor laboratories for training graduate students in the wildlife profession.

Since the inception of the Cooperative Wildlife Research Unit Program in 1935, the institute has been one of the four "cooperators"; the others are the U.S. Fish and Wildlife Service, the state conservation agency, and the land-grant college or university at which the unit in question (there are 16 of them) is located. Like the institute's Canadian stations, these units train graduate students, and the unit leaders carry on continuing research of a special or long-term nature.

The institute is a nonprofit, tax-exempt membership organization governed by a board of directors under the chairmanship of Egbert C. Hadley of Middlebury, Vermont. Ira N. Gabrielson, its president, is a former director of the Bureau of Biological Survey and U.S. Fish and Wildlife Service. He is an internationally known conservationist and ornithologist and the author of many articles and books in these fields. C. R. Gutermuth, the vice president and secretary, is the institute's representative to the AAAS Council.

C. R. GUTERMUTH

Wildlife Management Institute, Washington, D.C.

Forthcoming Events

June

1–3. Evolution, symp., annual, Saskatoon, Saskatchewan, Canada. (Mrs. L. C. Metivier, Royal Soc. of Canada, Natl. Research Bldg., 100 Sussex Dr., Ottawa.)

1–4. American Dermatological Assoc., Atlantic City, N.J. (W. M. Sams, 25 Southeast Second Ave., Miami, Fla.)

1–4. Spectroscopy, 10th annual symp., Chicago, Ill. (G. W. Bailey, Borg-Warner Research Center, Des Plaines, Ill.)

1–5. International Silk Assoc., cong., Munich, Germany. (H. Bonvallet, 25, Place Tolozan, Lyon 1, France.)

1–6. International Commission for Northwest Atlantic Fisheries, 9th annual (by invitation), Montreal, Canada. (ICNAF, Forest Bldg., Carlelon St., Halifax, Nova Scotia.)

2–6. American Rheumatism Assoc., Washington, D.C. (E. F. Hartung, 580 Park Ave., New York 21.)

2–6. Rheumatic Diseases, 2nd Pan American cong., Washington, D.C. (R. T. Smith, West Point, Pa.)

3–5. Cellular Aspects of Immunity, symp. (by invitation), Royaumont (near Paris), France. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

3–7. American Assoc. of Bioanalysis, Cincinnati, Ohio. (L. D. Hertert, 490 Post St., Room 1049, San Francisco 2.)

3–7. American College of Chest Physicians, Atlantic City, N.J. (M. Kornfeld, 112 E. Chestnut St., Chicago, Ill.)

3–10. Quantitative Biology, symp., 24th, Cold Spring Harbor, N.Y. (M. Demerec, Director, Biological Lab., Cold Spring Harbor, N.Y.)

4. Fine Structure as Related to Absorption, Synthesis and Transport in the Gastrointestinal Tract, symp., Atlantic City, N.J. (E. C. Texter, Gastroenterology Research Group, Medical School, 303 E. Chicago Ave., Northwestern Univ., Chicago 11, Ill.)

4. Petroleum Geochemistry, symp., New York, N.Y. (E. G. Baker, Esso Research and Engineering Co., P.O. Box 51, Linden, N.J.)

4–5. American Geriatrics Soc., Atlantic City, N.J. (R. J. Kraemer, 2907 Post Rd., Warwick, R.I.)

4–6. Endocrine Soc., 41st annual, Atlantic City, N.J. (H. H. Turner, 1200 N. Walker, Oklahoma City, Okla.)

4–7. American Medical Womens Assoc., Atlantic City, N.J. (Miss L. T. Majally, 1790 Broadway, New York 19.)

4–7. American Therapeutic Soc., Atlantic City, N.J. (O. B. Hunter, Jr., 915 19 St., NW, Washington 6.)

4–9. Electrolytes, intern. symp., Trieste, Italy. (Societa Italiana per il Progresso delle Scienze 7, Rome, Italy.)

5–7. American College of Angiology, 5th annual, Atlantic City, N.J. (A. Halpern, 11 Hampton Court, Great Neck, N.Y.)

5–7. American Gastroenterological Assoc., and American Gastroscopic Soc., annual, Atlantic City, N.J. (H. M. Pollard, University Hospital, Ann Arbor, Mich.)

6. American Acad. of Tuberculosis Physicians, Atlantic City, N.J. (O. S. Levin, P.O. Box 7011, Denver 6, Colo.)

6. International Cardiovascular Soc. (North American Chapter), Atlantic City, N.J. (P. T. DeCamp, 3503 Prytania St., New Orleans, La.)

6–7. American Diabetes Assoc., Atlantic City, N.J. (E. Paul Sheridan, 1 E. 45 St., New York 17.)

6–7. Society of Investigative Dermatology, Inc., 20th annual, Atlantic City, N.J. (H. Beerman, 255 S. 17, Philadelphia 3.)

6, 20, and *27.* Recent Advances in Medical Technology, symp., Staten Island, N.Y. (N. Colosi, Wagner College, Staten Island, N.Y.)

7–11. American Soc. of Heating and Air Conditioning Engineers, semi-annual, Vancouver, B.C., Canada. (A. V. Hutchinson, ASHACE, 62 Worth St., New York 13.)

7–13. Fertility and Sterility, 3rd world cong., Amsterdam, Holland. (W. W. Williams, 20 Magnolia Terrace, Springfield, Mass.)

8–12. American Medical Assoc., Atlantic City, N.J. (F. J. L. Blasingame, 535 N. Dearborn St., Chicago 10, Ill.)

8–12. Association for Research in Ophthalmology, Inc., Atlantic City, N.J. (L. V. Johnson, 10515 Carnegie Ave., Cleveland 6, Ohio.)

(See issue of 17 April for comprehensive list)

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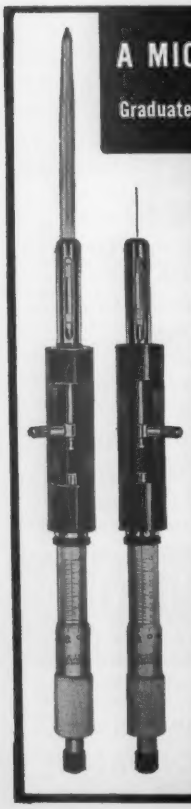

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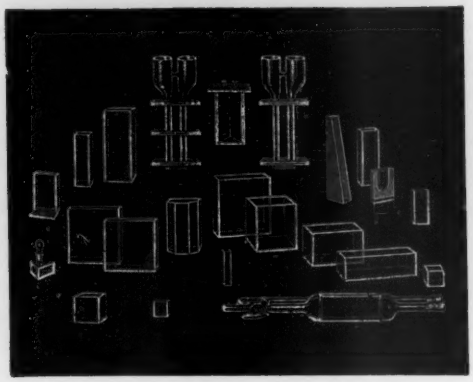

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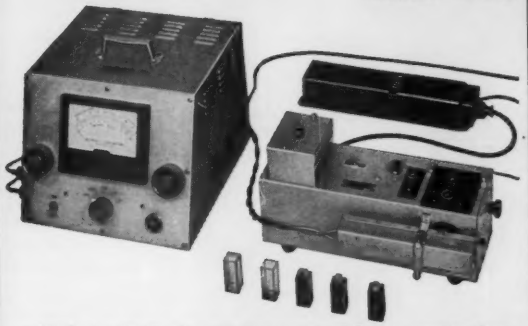

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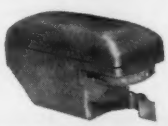

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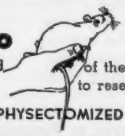

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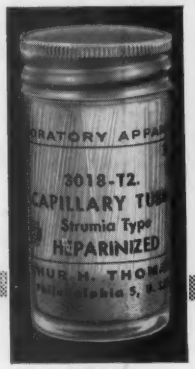

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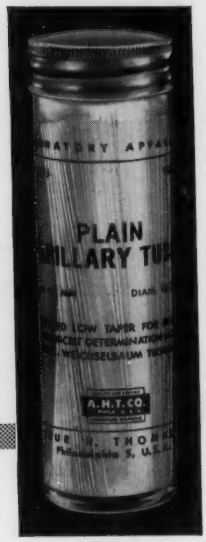

3018-J.

CAPILLARY TUBES, Heparinized, of soda-lime glass, for determining blood cell volume by Guest-Weichselbaum technique. With thin wall and open ends; specially selected for freedom from taper and curvature. Length 75 mm, outside diameter 1.2 to 1.4 mm. Packed in nickel plated screw cap, plastic vials with polyurethane pad in top and bottom.

3018-H. Capillary Tubes, Heparinized, as above described.
Per ½ oz. vial of approximately 100..... **1.15**
3018-J. Ditto, but without heparin coating.
Per ½ oz. vial of approximately 100..... **.80**

10% discount in carton containing 12 vials
15% discount in lots of 72 vials } *3018-H and 3018-J,*
20% discount in lots of 144 or more } *one number or assorted*

CAPILLARY TUBES, Strumia Type, Oxalated, of soda-lime glass, carefully selected for uniform inside diameter, for use in 3018-P Centrifuge. Size 32 mm long × 0.8 mm outside diameter, with open ends and uniform wall 0.1 mm thick. Prepared to precise tolerances and coated with anticoagulant mixture of ammonium and potassium oxalate in accordance with Strumia technique. Packed in transparent plastic, screw cap vials containing 500.

3018-T. Capillary Tubes, Strumia Type, Oxalated, as above described.
Per vial of 500..... **6.25**
3018-T2. Ditto, but with heparin (ammonium heparinate) coating, which is preferred by some technicians. **Per vial** of 500..... **7.25**
3018-T5. Ditto, but without oxalate or heparin coating. **Per vial** of 500... **4.50**

10% discount in lots of 12 vials } *3018-T, 3018-T2 and 3018-T5,*
15% discount in lots of 24 vials } *one number or assorted*

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